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ABSTRACT

This guide identifies technicians, states specific job requirements, and describes special problems in defining, initiating, and operating post-high school programs in data processing technology. The following are discussed: (1) the program (employment opportunities, the technician, work performed by data processing personnel, the faculty, student selection and services, textbooks, references and visual aids, laboratory equipment and facilities, the library, scientific and technical societies, and advisory committees and services); (2) the curriculum (outline, brief description of courses, curriculum content and relationships, suggested continuing study, and cooperative vocational education programs); (3) course outlines (technical--computer science, operations and programming; systems development and analysis, and data base management--math--including business statistics--supporting courses--business and accounting--and general courses--communication skills and society and working relationships); (4) lab equipment and facilities (transporting student to computer facilities, terminals only, on-campus computer facilities, equipment costs, supplies, and non-instructional support); and (5) library support (staff, budget, and content). A bibliography is appended, as are lists of film distributors and professional societies and associations in data processing and a summary of the curriculum pilot study. (KM)

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DATA PROCESSING TECHNOLOGY

A Suggested 2-Year Post High School Curriculum

ED 085056

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FOREWORD

The rapid growth of computer and data processing technology has made it necessary to provide an educational opportunity for a large number of students who seek careers as skilled technicians. Their objective is to become specialized assistants to professional personnel in science, engineering, business, and associated professions. This requirement has caused a rapid growth in existing programs and in the demand for new programs to prepare data processing technicians in public junior and community colleges, technical institutes, and area vocational and technical schools.

Guidelines for establishing quality programs for data processing technicians are needed to assist many administrators who desire to establish such programs but who are unfamiliar with the technical areas involved. Although this publication deals only with post high school programs, some of the material may be adapted for use in high schools to lead the student either to employment or to continued study.

This suggested guide identifies technicians, states specific job requirements, and describes special problems in defining, initiating, and operating programs. It presents recommendations for classroom specifications, for laboratory and library facilities, the library collection, faculty development, student selection and services, and the curriculum. The material presented reflects the accumulated experience of successful programs and the consensus of many technician educators. Employers, school administrators, teacher educators, consultants, and other persons who have distinguished themselves in the field of technician education, have made substantial contributions to this publication.

This volume is designed to assist Federal, regional, State, and local technician educators and their advisory committees in initiating new high quality data processing education programs or in improving programs already in progress. It will also assist teacher educators, program evaluators, employers of technicians, guidance counselors, and others interested in technical education.

This guide was developed under the direction of Alton W. Ashworth, Jr. and Suzette Gebolys, Central Texas College, with the assistance of William Berndt and Walter J. Brooking, members of the Bureau of Adult, Vocational, and Technical Education of the Office of Education, Department of Health Education, and Welfare.

L. M. Morton, Jr.
President
Central Texas College
Killeen, Texas

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Stephen Choolfain, Assistant Director, Information Services Division, Lever House, 390 Park Ave., New York, N. Y. 10022

John De Jong, Assistant Secretary for Advanced Planning, United States Trust Company of New York, 45 Wall St., New York, N. Y. 10005

Clarence Dillard, Systems Analyst, Computer Applications Department, Statistics Research Division, Research Triangle Institute, P.O. Box 12194, Research Triangle Park, N. C. 27709

Jerry S. Dobrovolny, Head of Department of General Engineering, University of Illinois, 117 Transportation Bldg., Urbana, Ill. 61801

John J. Fitzsimons, Branch Manager of Federal Government Marketing, INFONET Division, Computer Science Corporation, 650 North Sepulveda Blvd., El Segundo, Calif. 90245

Robert Gates, Vice President for Support Services, Box 816, Edinboro State College, Edinboro, Pa. 16412

George G. Heller, Director of Education, Association for Computing Machinery, 1133 Avenue of the Americas, New York, N. Y. 10036

L. William Lauritzen, Director of Administration, Systems and Data Services, Trans World Airlines, Inc., Administrative Center, Highway 29 and 112th St., Kansas City, Mo. 64153

Ralph E. Lee, Director of Computer Center, University of Missouri-Rolla, Edgar Star Route, Rolla, Mo. 65401

Arnulfo L. Oliveira, President, Texas Southmost College, Brownsville, Tex. 78520

Albert Prioletta, Project Coordinator, Medical and Health Research Association of New York City, Inc., 40 Worth St., New York, N. Y. 10013

Gus Rathe, Resident Manager, IBM Corporation, 7701 Stemmons Freeway, Dallas, Tex. 75247

Alfredo de los Santos, President, El Paso Community College, El Paso, Tex. 79998

Jimmie C. Styles, Vice Chancellor for Research and Development, Tarrant County Junior College District, 1400 Ft. Worth National Bank Bldg., Ft. Worth, Tex. 76102

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THE PROGRAM

There were fewer than 15 electronic digital computers in worldwide use in 1950. By the late 1960's, however, more than 40,000 were in operation; the number is expected to increase to more than 100,000 during the 1970's.

U.S. manufacturers fabricated and marketed 10,200 computer systems in 1966; they are expected to produce about 84,000 systems in 1975. It is estimated that in the 22-year period, 1953-75, nearly 400,000 computer systems valued at 82.4 billion dollars will have been produced by U.S. firms.

Substantial accomplishments in computer research and development led to the remarkable growth of the computer systems market. By the late 1960's, computers operated at 20 to 100 times the speed of their 10-year-old counterparts. Within the same 10-year period, data storage capacity was increased eightfold, while the storage equipment itself could be accommodated in less than half the space required formerly. Concurrently, computer technology penetrated, directly or indirectly, nearly every area of human existence.

Computers have been put to work on innumerable tasks. They are employed to design ships, to aid in their construction, and to operate and navigate the completed vessels on, and under, the high seas. Computers made possible the design and construction of spacecraft, their launching, control, and navigation to the moon; their landing on the lunar surface, and the safe relaunch and return of spacecraft and crew to earth. Computers also have been applied to less exotic but none the less significant roles in the functions of government, law enforcement, education, business, commerce, and the sciences. The essentially unlimited utility of the computer itself has been augmented in recent years by the accelerating development of peripheral equipment and data communications systems. This development has brought about the use of networks in which a single computer located in one city provides service to terminals in other cities across the nation.

The response of the non-technical public to the intrusion of the computer into their lives correlates to their concepts of its capabilities. Some view the computer as a miracle machine that someday will relieve mankind of all burdensome labor; others look upon it as an encroaching electronic monster that one day will rule their lives. Oddly, these emotional, non-technical convictions are somewhat akin to the more objective, professional concepts held by computer scientists and by authorities in related fields. For example, although there is no consensus among these authorities identifying the outer limits of the computer's potential applications to the advantage of mankind, there is agreement that such potential can be released with immensely destructive impact on the affairs of man.

There is common understanding that computer applications potential is not yet limited by computer capabilities. Instead, the realization, enlargement, and character of the ultimate potential is limited only by the technical training and ability and ethical standards of the user.

The phenomenal development of computer technology and manufacturing and the accelerating expansion of computer use have created an increasing demand for data processing technicians. Extensive requirements exist for technicians in the "software" field; that is, the programming and use of the computer and its peripheral equipment. "Hardware" functions are those related to the equipment itself. In the latter area, technicians are developed by educational programs in engineering.

Our national need for software technicians imposes unique demands on the educational community. The technical knowledge required by keypunch operators, computer operators, programmers, and junior and senior systems analysts has been acceptably identified. Offering only technical knowledge is inadequate; it is equally incumbent on the educational process to provide student technicians with an alert consciousness of their responsibility to the society of which they are a part. Certainly, education cannot be expected to provide them with the answers to questions that are yet to arise. Just as certainly, education *should* equip students with ethical concepts that will help them to recognize the point at which they should question the general fitness of what they do as it may affect the welfare of society.

Therefore, this curriculum guide is designed for use as an aid in preparing technicians who are both technically competent and ethically responsible.

Employment Opportunities

Many studies have attempted to assess the number of trained personnel needed to effect maximum use of computers now in existence and those projected to be manufactured and placed in service by 1975, 1980, even 1985. While there is considerable disparity in the results of these studies, all are consistent generally in their estimates that a shortage of trained data processing personnel exists now and is expected to continue indefinitely. Included in the zone of consideration are EDP clerks, keypunch and other peripheral equipment operators, terminal operators, computer operators, programmers, and systems analysts. However, in the data processing field, as in all areas of endeavor, there is a particular demand for personnel with a substantial background of sound training and a record of academic or on-the-job competency. Employers can ill afford inadequately trained employees in data processing operations where the opportunity for error is great, and the cost of error is sometimes disastrously high.

While it can be accepted reasonably that employment opportunity exists and probably will increase in the data processing field, the range of opportunity is related directly to the qualifications of the job candidate. For this reason, it is the responsibility of those who prepare students for job entry into data processing to insure that the preparation is adequate to both the needs of the students and their future employers.

The Technician

The occupational performance of data processing technicians is affected significantly by factors over which they can exercise some control. Within the limits of standard operation procedures and problem characteristics, graduate technicians are offered a maximum opportunity for professional development. This professional development naturally is contingent on the level of training achieved by the graduate.

The occupational activities of data processing technicians are characterized by diversity. Typically, the development of economic models, simulation techniques, statistical programming, and mathematical models frequently comes within their realm of responsibility. They must be capable, therefore, of working and communicating directly with engineers, scientists, and other personnel; of satisfactorily performing work for their employers, and of growing into positions of increased responsibility. In addition, the graduate technician should have a foundation for developing as an active, well-informed member of society.

In order to satisfy these functional requirements, a successful data processing educational program must aim to develop specialized persons who are able to perform tasks requiring precision skills and who approximate the professional in education, attitude, and competence. Such programs provide for rigorous study of scientific principles and supporting mathematics, and for intensive laboratory and field practice related to the instruction. Students must be provided with opportunities to gain:

1. Knowledge of applied scientific principles, equipment, industrial processes, techniques, materials, and instruments.
2. Ability to serve as assistants to professional engineers, scientists, or professional personnel in other fields.

Particular attention must be given to the design of a program that is expected to produce graduates with the characteristics described above. Each course must be directed toward equipping the student with expertise in its subject matter areas, but it also must be designed as a functional element of the total program, contributing toward the specific objective of producing a competent technician. The correlation of courses within the program is essential in order for students to acquire the in-depth understanding that their employers will require of them.

Successful post high school data processing training programs concentrate on primary needs; they are realistic and pragmatic. In the same mode, the program suggested in this curriculum guide has been designed to provide maximum technical instruction in the time that is scheduled, while still encouraging students to explore areas of interest that will nourish and strengthen their human potential.

To those who are unfamiliar with this type of educational service (or with the goals and interests of students who elect it), a data processing program often appears to be inordinately rigid and restrictive. While modifications may be necessary in certain institutions, the basic structure and content of the program should be maintained.

The specialized technical courses are both laboratory and field oriented. They provide time

for the application of the scientific principles concurrently being taught in mathematics and in other supporting and auxiliary courses. In addition, general education courses constitute a small but crucial part of the total program. It has been found that students who enter a technically-oriented program do so because of the depth of specialization that the program provides. Further, they recognize an enlarged responsibility to themselves and to society, a responsibility that extends beyond their career contribution.

Work Performed by Data Processing Personnel

Since personnel designations are identified in terms which were nonexistent a decade ago, job descriptions and responsibility assignments in the field of electronic data processing are fluid. Activities for which no precedents were found in the pre-computer era have accompanied the development of computer technology. New terminology is generated for new concepts and practices previously untried.

Sufficient stability has been achieved, however, to allow tentative designations for specific job clusters. Since each cluster may require somewhat different abilities as well as specialized knowledge and skills, data processing graduates normally will continue to develop their abilities through study on the job or in part-time study to master the specifics of a particular field.

This manual is focused primarily on the curriculum of a 2-year post high school program in electronic data processing that will prepare graduates to enter the work force as programmers or as systems analysts. These two job categories are defined as follows:

1. Programmer: Flow-charts program specifications, prepared usually by a systems analyst; codes the flow-charted data into a programming language; uses selected data to test and correct the completed computer program.
2. Systems analyst: Defines and analyzes a given problem; defines data parameters, acquires data, and develops a problem solution; prepares specifications used by the programmers to prepare a computer program.

Graduates of data processing programs at the

Figure 1. — Student keypunch operators must be provided with machine operation experience to prepare them for job entry. Keypunch and verifier units must be available in sufficient numbers to meet this requirement.

secondary or 1-year post secondary level usually have received preparation qualifying them for employment as keypunch operators, electronic data processing clerks, remote terminal operators, and computer operators. Students who follow the 2-year curriculum outlined in this manual likewise acquire the knowledge and skills to enter the work force in these positions, defined as follows:

1. Keypunch operator: operates an alphabetic and numeric keypunch machine, similar in operation to an electric typewriter, to transcribe data from source material to punched cards in order to produce prepunched data.
2. Electronic data processing clerk: schedules programmer and computer availability for users; organizes user programs in sequence for processing.
3. Remote terminal operator: operates a CRT (visual screen) terminal or other terminals that produce hardcopy printouts only, controls work flow as designed, and updates changes to data systems files.
4. Computer operator: monitors and controls electronic digital computer to process business, scientific, engineering, or other data according to operation instructions.

Figure 2. — Laboratory facilities must include equipment that is sufficiently up-to-date to permit its use in current data processing practices. The magnetic tape drive in use by this student exemplifies such equipment.

Table 1 summarizes the job descriptions, orientation, and preparation commonly suggested for these six data processing positions.

The Faculty

The effectiveness of any program depends largely upon the competence and enthusiasm of the instructional staff. The specialized nature of the data processing program necessitates that its instructors demonstrate special competence based both on proficiency in technical subject matter and on industrial or business experience. It is important also that all members of the faculty understand the educational philosophy, goals, and unique requirements characteristic of this program.

To be maximally effective, members of the faculty responsible for the program must have interests and capabilities which transcend their areas of specialization. Particularly, they should be reasonably well-informed of the requirements for study in computer management practices so that they may use field examples and illustrations as supporting material in their courses.

A minimum of three full-time faculty members is required to teach the technical specialty courses in a typical data processing curriculum, bearing in mind that entering classes of 20 to 30 students can be taught in lectures but may have to be divided into two sections of 12 to 15 for laboratory work. One of the full-time instructors usually is recognized as the head of the program and can be expected to devote about half-time to program administration.

The department head must be technically competent in data processing, able to plan and equip the facilities, capable of developing and initiating the curriculum, able to provide the necessary leadership in student selection and graduate placement, and qualified to develop the coordinated departmental teaching effort which will result in completeness and excellence in the program. This individual should work with the local advisory committee, and should in other ways lead the program with the support of the school administration. The department head and at

Figure 3. — Disk packs are devices used for storing computer data. Here, a student technician selects a disk pack from its file preparatory to loading it in one of the disk drive units in the background.

Table 1. — Job characteristics, data processing technicians

Title	Function	Knowledge	Interface	Orientation	Experience	Education requirement for entry
Keypunch operator	Transcribes source data; may tend machines that automatically sort punchcards	Transcription and collation techniques	User data, EDP clerk, programmer	Software preparation	Machine operation and maintenance	High school technical program or 1-year post secondary
Remote terminal operator	Operates CRT or other remote terminals	Computer operation procedures, work flow control, and data systems files	EDP clerk, programmer, computer operator	Work flow organization, hardware, software	Terminal operation and maintenance	High school technical program or 1-year post secondary
Electronic data processing clerk	Schedules computer and preparation time	Office organization and management	User, keypunch operator, programmer	Clerical organization and management	Office scheduling	High school technical program or 1-year post secondary
Computer operator	Monitors computer according to program format	Computer functions	EDP clerk, programmer	Hardware	Machine functions	1- or 2-year post secondary data processing program
Programmer	Prepares, debugs, and tests programs according to specifications prepared by systems designer	Programming, computer capability, software capability	Computer operator, systems analyst	Software, hardware	Programming languages	2-year post secondary data processing program
Systems analyst	Refines problems and data into programmable format	Computer capability	User, programmers	Software, hardware	Programming experience desirable	2-year post secondary data processing program

least one instructor must be employed during the first year of the program, and an additional instructor, perhaps more, will be needed during the second and subsequent years.

In addition to the three data processing instructors, at least two full-time faculty members must be available to teach communication skills, technical reporting, mathematics, basic science, and general courses in the curriculum. These courses should be designed to meet the specific needs of data processing students. The purpose generally cannot be served by the use of materials selected and presented originally to achieve goals in another subject area. While the institution already may have sufficient staff to prepare and teach data processing supportive courses to student technicians, care must be taken so that instructors are not overloaded with the requirements of the new program.

Staff to teach and supervise laboratory projects and to supervise work experience in cooperative educational programs off campus must be professionally and technically competent, able to cope with the interpersonal relationships of school and employer, and able to exercise a high degree of independent judgment as teachers and representatives of the school.

If the scope and depth of training are to be adequate, programs for highly skilled data processing technicians must be a series of well-integrated courses. Therefore, careful consideration must be given to the timing of the introduction of new concepts. This may, perhaps, be accomplished through "team-teaching," in which the technical staff is organized into coordinated teaching units. Teaching assignments are then made on the basis of the individual member's special training and talents. Concurrent courses are closely coordinated by team members to best utilize the students' time while they are moved smoothly on to progressively higher levels of understanding.

"Team-teaching," like any sound instructional technique, can be developed and nourished only by the teaching faculty. A weekly departmental staff meeting to encourage development and ex-

Figure 4. — Hands-on experience with computer equipment is provided as an essential part of the learning process. This student is working in a setting that duplicates the environment she can expect in her future employment.

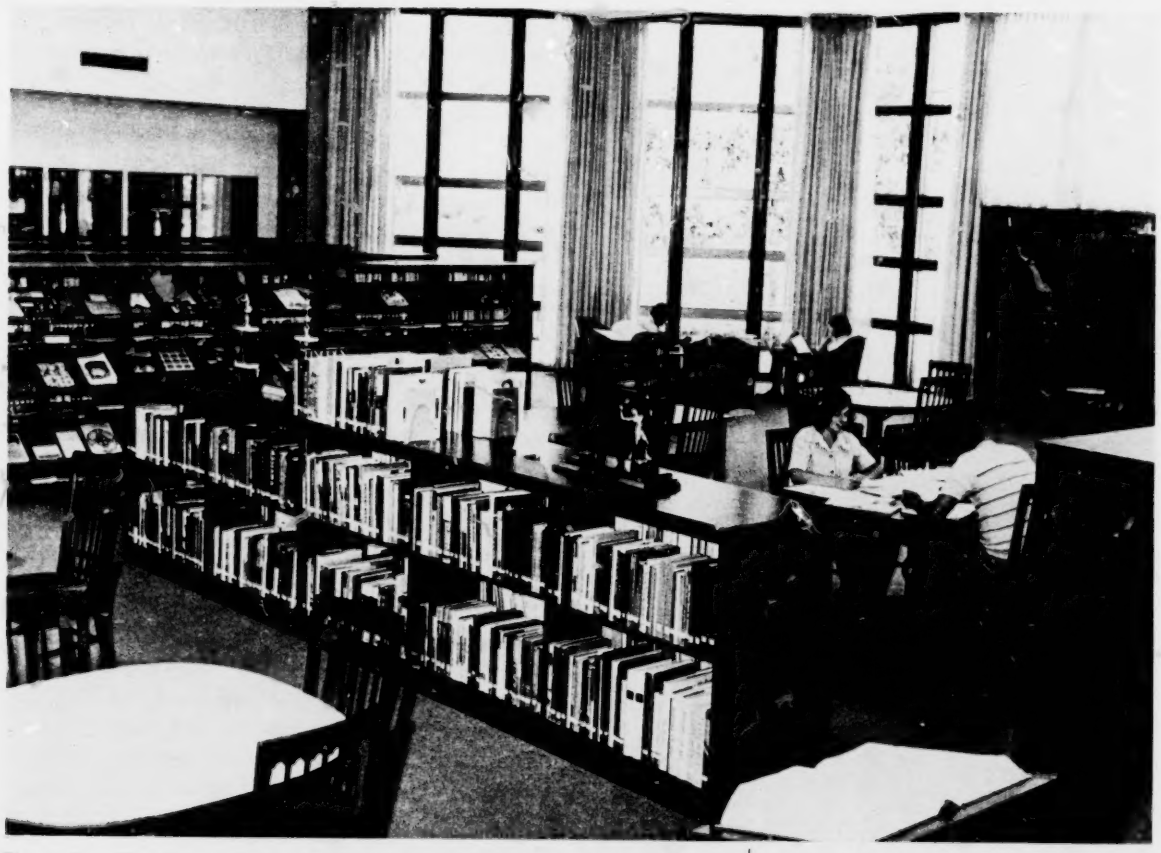


Figure 5. — The library environment and content should be designed to meet the needs both of part- and full-time students pursuing a post high school program.

perimentation with teaching methods is recommended. At these sessions, instructors could verify that the coordination of concurrent courses, such as *Business Statistics* and *Business Systems Development*, is maintained and that new concepts or techniques are receiving similar presentations.

In addition to keeping concurrent courses well-coordinated, staff meetings can provide for interchange of ideas on teaching techniques discovered to be useful, and on recently developed laboratory projects which seem to be particularly successful. Furthermore, the meetings provide an opportunity for the discussion of scientific and technical journal articles which may enhance classroom teaching or which may present new information which should be taught.

The most competent faculty members will never feel that they have completely mastered their respective areas of expertise. Throughout their professional careers they will remain alert to new methods, materials, and equipment. They will continue to read, to study, to maintain contact with the changing concepts of data processing, and to visit business and industrial programs. While individual efforts toward self development are considered to be ordinarily characteristic of a professional attitude, such activities should be supported substantially by administrators and program heads. Funds judiciously budgeted for faculty members to travel to selected professional conferences can produce new knowledge with which to enliven even a successful program.

Institutions can promote staff effectiveness further by encouraging faculty members to participate as active members of professional and technical societies. Through such organizations they can keep up with new literature and maintain closer liaison both with employers of technicians and with key leaders in the data process-

Figure 6. — The periodicals section of the library warrants particular attention from data processing instructor and student alike. Technical publications are the best available source of new, complete, and authoritative technological information.

ing field. School administrators are increasingly encouraging the self development of staff members by providing released time and financial assistance to those who attend society meetings and teacher-training institutes. Periodic or sabbatical leaves should be extended likewise to staff members to afford them the chance to update and broaden their industrial experience or to allow for further study.

Programs in data processing technology are designed to develop supporting employees who increase the effectiveness of analysis teams. The same principle of assistance may be employed to increase the effectiveness of the teaching staff. Staff assistants may be used in stock control, to organize the proper equipment for laboratory sections, to keep equipment operating properly, to fabricate training aids, and to do a limited amount of routine paper grading. When assistants do these important but time-consuming jobs, the instructional staff can devote more time to developing courses, to preparing handouts to supplement lecture material, and to insuring that necessary components and properly functioning equipment are available when needed. Resourceful use of supporting personnel makes it possible to have a small but versatile staff which may be maintained as enrollment varies. By adjusting the size of the supporting staff to the demands of enrollment, a school may at least partly solve the problem of having too few instructors when the enrollment is reduced. Most of the supporting staff may be recruited from the student body or graduates from the program.

When determining teaching loads for teachers of data processing courses, administrators should consider the number of student contact hours required by their schedules. Fully effective instructors in this field require considerably more time to develop courses and laboratory materials than do other subject-matter instructors. A contact hour workload of from 15 to 20 hours a week usually constitutes a full teaching load for data processing teachers. The rest of their time should be spent in assisting students and in developing courses and effective laboratory projects.

Class size also must be considered in encouraging effective instruction, since individual attention is commonly recognized as a vital component in teaching. The maximum size of a lecture class may vary somewhat depending on the material to be covered, characteristics of the lecture room, and the teaching techniques employed. For blackboard lecturing, class sizes of 20 to 30 students usually should be considered optimum. If the lecture involves only limited discussion and the parts of the presentation normally written on the blackboard are prepared for an overhead projector, the size of the class may be increased.

In addition, the planning of laboratory activities requires particular care. Laboratory sections should not be overloaded with students. Teach-

ing cannot be of maximum effectiveness if there are too many students per work-group or if too many different projects are in progress simultaneously in the same laboratory. This especially is the case where a project requires "hands on" use of a computer or peripheral equipment. If too many students try to work at a single terminal, for example, most of them will not benefit because they cannot participate sufficiently in doing the work. An optimum group size usually is two, although some projects can be effective for groups of three or even four students. However, if too many projects are in progress, the instructor cannot be suitably attentive to each and the work cannot be coordinated closely with theory lectures.

Student Selection and Services

Since the ultimate objective of this program is to produce high-quality graduates at the post high school level, it is essential that the students admitted into the program have certain capabilities. If the incoming student's background is inadequate, the instructors may tend to compromise the course work to allow for these inadequacies, with the probable result that the program will be inferior in depth and scope.

Usually, the prerequisites include graduation from high school or its equivalent, with accreditable completion of:

1. Three standard secondary units of English. The student should be able to demonstrate capability in reading, writing, and oral communication.
2. Two standard secondary units of mathematics, including algebra and plane geometry or their equivalents. Intermediate algebra and trigonometry are desirable but are not required.
3. At least one standard secondary unit of science.

Prospective students who have completed high school data processing courses successfully should be given appropriate credit. Those who have had data processing job experience also should be given suitable credit contingent on completing equivalency testing satisfactorily.

Many institutions offering technical programs at the post high school level also provide pretechnical instruction up to a full year's duration. This affords promising but under-prepared students the opportunity to enter a data processing program with a good probability of successfully completing it. Thus, fewer students experience the harmful effects of academic failure, and the program benefits in that the adverse financial impact resulting from tuition refunds is kept at a lower level. Pretechnical programs also reduce student recruitment problems, provide assurance of a high quality of graduates by starting with adequately prepared students, and give promising students an opportunity, limited only by their ability and industry, to develop marketable job skills.

The students ultimately admitted to the program should have similar backgrounds and capabilities and should exhibit some evidence of maturity and seriousness of purpose. Wide ranges of ability among students can create an inefficient teaching situation and thereby prevent the program from progressing at the necessary rate. The amount of material to be presented and the principles to be mastered require students who not only are well-prepared in formal course material but who also have the personal motivation to master a difficult program and to develop their capabilities to the limit.

At any level of preparation, effective guidance and counseling are essential to the technical student. Wherever possible, students should be aided in selecting educational and occupational objectives consistent with their interests and aptitudes. Institutions offering data processing programs might consider using standardized or special tests to assist in student selection, placement, and guidance. Students should be advised to review their educational objectives if it becomes apparent that they lack interest in the program or lack ability to complete it satisfactorily.

Students should be familiarized with the facilities on campus. In particular, they should be given a tour of the computer facilities and the library, and be made aware of the procedures and rules for their use. If possible, organized trips to nearby industries and businesses should be arranged early in the program to give new students an opportunity to stimulate personal motivation and to clarify their understanding of why certain required subjects are important.

Students should be given information concerning membership in technical societies and be encouraged to join such organizations. Student

chapters of professional societies offer an opportunity for the student technician to receive excellent material on a regular basis at nominal cost and to associate with professionals in data processing technology. After graduation, the technician may find affiliation with a society and reading of journal articles an important means of keeping his technical knowledge current.

The academic achievement of students should be recognized in some manner. A departmental club might present an annual award to an outstanding graduate; private companies might offer to contribute to an annual scholarship award. At the post-secondary level, many institutions grant graduates an associate degree as tangible recognition of achievement. In any event, recognition of student achievement and excellence is a valuable motivation tool not to be lightly dismissed in any program.

Graduates of the data processing program should be aided in every way possible in finding suitable employment. Placement officers should be aware of the needs of the region's business and industrial computer centers and should acquaint prospective employers with the qualifications of graduates. The placement function is an extremely valuable service to the student, the institution, and the employers. An excellent placement record is important in attracting new students. Moreover, the school should conduct periodic follow-up studies of its graduates to determine their progress and evaluate their training. Such studies can indicate how the program or teaching techniques can be improved to meet current employment requirements and trends.

A commitment should be made to determining and meeting both the immediate and long-term needs of the students enrolled in the program. This commitment encompasses sound academic preparation, vocational and personal counseling, and job placement.

Textbooks, References, and Visual Aids

Textbooks, references, and visual aids for teaching any science must be reviewed constantly and supplemented in light of the rapid development of new knowledge in the field and the results of research in methods of teaching and developing basic concepts in the physical sciences and mathematics. This is especially true in the field of data processing where the impact of the development of whole new areas of theoretical and applied scientific knowledge is demanding new textbooks, new references, articles in scientific and technical journals, and new visual aids material.

Textbooks will reflect current methods of teaching scientific principles and applications as fast as research in education proves applicable. Recent extensive research in methods of teaching mathematics and physics certainly will produce changes in teaching materials and methods for data processing. It is mandatory therefore that instructors constantly review modern texts, references, and visual aid materials as they become available and adopt them when they represent an improvement over those suggested here or those currently in use.

The texts and references suggested in this curriculum guide have been carefully reviewed and selected. From the lists presented, it should be possible to select suitable ones; it should not be interpreted, however, that unlisted books are unsuitable.

Visual aid sources provided in appendix A have been selected from an extensive list and represent those considered to be suitable at the time the curriculum was prepared. Because the number of such sources makes an all-inclusive listing prohibitive, many are not listed. From those listed and others currently available, an instructor may select visual aids that meet stated teaching objectives. Always, however, visual aids should be previewed and studied before they are used.

Instructors undertaking to prepare any course contained in the curriculum should familiarize themselves with the texts and references listed in the course outlines and with others that are available. They then will be able to select materials that best meet their particular needs and best promote a lucid, high-level technical presentation to their students.

Laboratory Equipment and Facilities

Laboratory experience is a vital part of any data processing program and is considered essential to achievement of the curriculum objectives. A recommended approach to developing laboratory work and equipping the laboratories is to determine what experiments and experience are

needed for each course. Exercises then should be designed, so far as possible, using standard equipment representative of that currently used in industry and business. This approach requires staff time and effort but, because the experimental equipment has been assembled to demonstrate some principle or to make a specific experimental determination with clarity and precision, it usually results in the best instructional presentation.

Equipment selection is a consideration of prime importance to the effectiveness of the curriculum. Selection should be based on how well the instructional environment simulates business and industrial practices. The equipment used in a data processing laboratory is expensive and tends toward obsolescence after but a few years of use. To help minimize this financial burden, many equipment manufacturers now offer a lease program with an educational discount. The question of lease or purchase is one which each institution will have to resolve. It will suffice here to point out that a danger exists in attempting to utilize a purchase system beyond the limits of practicality, whereas a leased system is more easily "modernized" when economic concern is paramount.

Consideration also should be given to the possibility of utilizing remote terminal units connected to a conveniently available central computer facility whenever such a facility exists in the area. This may well prove more economical than investing in a central processing unit to be installed in the institution itself. Furthermore, access to a machine much larger and more powerful, and, therefore, possessing far greater capabilities than one likely to be found suitable for an educational institution, would provide opportunities for more comprehensive programming exercises.

Obviously, there are many system configurations which will meet the minimum requirements for a program such as described in the following course outlines. However, valuable insights can be gained by utilizing the professional advice and recommendations of an advisory committee of educators and local and national employers of data processing personnel. No decisions on the procurement of equipment should be taken without the reactions of such a committee.

A further consideration when planning the facilities for the laboratory is the probability that the nature of the equipment may require some remodeling of the area in which it will be housed. For example, raised flooring may be necessary to accommodate electrical cables. Furthermore, air-conditioning may be highly desirable, both to promote human comfort and to provide the humidity and temperature control essential to the efficient functioning of the equipment and materials.

Each student should be allocated specific computer time. It is necessary to establish procedures which minimize individual monopoly and yet encourage activities beyond those specified as course requirements. This may be accomplished by exercising control of "prime" time and allowing sufficient time available after school and evenings for student use beyond the limits established in the individual courses.

The Library

Part of the strength of any program is indicated by the quality of its library as characterized by the qualifications of the librarian; the facilities; the quality, quantity, and relevancy of content, and the staffing and organization.

Dynamic developments causing rapid changes in data processing make it imperative that the students learn to use a library. Instruction, therefore, should involve the students in substantial library work for their various courses, both to develop the habit of using the library as a tool in learning and to help foster a professional attitude which regards libraries as a source for keeping abreast of new developments in the field.

Instructors of all courses should inform their students that library use is an important aspect of the program. Planned assignments that require the use of the library to prepare reports on pertinent subjects will enable students to understand the resources available and their relation to data processing.

For this reason, a central library under the direction of a professional librarian is important to the success of the program. Most instructors have private libraries in their offices from which they may select books of special interest to discuss in their personal conferences with students and thereby stimulate their interest in related literature. However, a central library insures the acquisition and cataloging of the library content according to accepted library practices and pro-

vides systematic card files that facilitate the location of reference materials. It also provides a controlled and orderly lending system typical of libraries which the students might use later as employed technicians. Provisions for lending materials for out-of-library use should be systematic and efficient. Suitable study space should also be provided students for use of reference works.

A library not only must provide adequate literature on the information encompassed by all subjects in the program, but also extend somewhat beyond the degree of complexity and depth of the presentations which students encounter in the classroom. Literature dealing with unusually highly specialized aspects of a subject may be acquired as needed or may be borrowed by the librarian from more comprehensive libraries.

The library should meet the needs both of full-time students and part-time students who are taking supplemental courses to upgrade or update their occupational knowledge and skills. In addition, it should serve the daily requirements of the instructors in their aim to keep their own technical knowledge abreast of the new developments pertinent to their special field of applied science.

In view of the highly specialized nature of library content for a data processing program, the department head or chief instructor should be a member of the library committee and should be responsible for approving the reference material selected for the technology and related courses. The librarian, as chairman of such a committee, may be expected to take the initiative in calling meetings or informally consulting with the head of the data processing department so that, within the limitations of the budget and the consideration of total library needs, the department will acquire the appropriate library content.

Scientific and Technical Societies

Scientific and technical societies and trade associations are an important source of instructional materials and other benefits for faculty members and students. Such societies provide, through their publications and meetings, immediate reports and continuing discussion of new concepts, processes, techniques, and equipment. The presentation and interpretation of scientific and technical discoveries explain the relationship of the theoretical scientist's work to the requirements of the applied science practitioner.

Less conspicuous, but extremely important, is the support which societies may give in helping to develop evidence of need for a training program, in helping to promote the program, in enlisting members' support for the program, in helping to provide work experience for students, and in helping with the placement of graduates.

Associations and societies may supply resource people to speak to classes; they may serve also as hosts to student groups on field trips to study specific phases of the technical area.

Instructors should be encouraged to become active members of these societies so that they may learn quickly of new technological developments. Membership will also enable them to meet people in the community who are most actively interested in the field. Some educational institutions pay all or part of the costs of membership dues and attendance at local or national meetings in order to encourage staff participation in selected societies.

Early in their studies, students should be invited to become acquainted with the literature and services of scientific, technical, and engineering societies. They should also be encouraged to join those which offer affiliate memberships.[1]

Many professional organizations and associations of manufacturers and producers serve the scientist, engineer, technician, administrator, teacher, student, and others dealing with the problems of data processing. These include:

- American Federation of Information Processing Societies (AFIPS)
- Association for Computing Machinery (ACM)
- Association for Educational Data Systems (AEDS)
- Association of Data Processing Service Organizations (ADAPSO)
- Association for Systems Management (ASM)
- Business Equipment Manufacturers Associations (BEMA)
- Data Processing Management Association (DPMA)
- International Federation for Information Processing (IFIP)
- Operations Research Society of America (ORSA)
- Project on Information Processing (PIP)

[1]See appendix B for descriptions of the history, purpose, and membership of these professional societies.

Society for Automation in Business Education (SABE)
Society for Technical Communication (STC)

Advisory Committees and Services

The success of post high school education programs in data processing technology depends significantly on the support of advisory committees. Thus, when an institution considers the advisability of initiating a particular program, the chief administrator or dean should appoint the advisory committee to assist in its development.[2]

The special advisory committee for the data processing technology program should comprise representatives of employers, scientific and technical societies and associations in the field, engineers employed in industry, computer operating personnel, and knowledgeable civic leaders who meet with and advise the specialists on the school's staff. Such members serve without pay as interested citizens. They enjoy no legal status, but proved invaluable assistance. The committee normally consists of about 12 members (but may range from six to 20), who generally serve for a 1- to 2-year period. The head of the institution or the head of the program ordinarily is chairman. Since such people are always busy, meetings should be called only when committee action can best handle a specific task or problem.

The committee assists in surveying and defining the need for the technicians; the knowledge and skills they will require; employment opportunities; available student population, curriculum, faculty, laboratory facilities and equipment; the extent of community support, and cost and financing of the program. When the studies indicate that a program should be initiated, the committee's help in its planning and implementing is invaluable.

Frequently, the committee substantially helps school administrators to obtain local funds and State and Federal support for the program. When the graduates seek employment, the committee aids in placing them in jobs and in evaluating their performance. Such evaluations often will result in minor modifications that relate the program more closely to employment requirements.

The advisory committee can use this curriculum guide as a starting point and modify it to meet local needs. The program can form the basis for courses to meet the requirements of employed adults who wish to upgrade or update their skills and technical capabilities, or to train high school students for entry into the job market. In this way the school administration, with the help of the committee and special consultants, can effectively initiate the needed program, quickly develop it to a high level of excellence, and maintain its timeliness.

The program is not intended to make individual students proficient in all the duties they might be asked to perform. Proficiency in highly specialized work will come only with practice and experience. It is impossible to forecast the exact requirements of the duties that may be assigned to any graduate technician, and it is almost impossible to predict accurately the course or rate of change in the technology. Employers generally recognize that recent engineering graduates may require a year or more to obtain the specific training they need and to orient themselves to their responsibilities and role in an organization. Similarly, employers of newly graduated technicians must generally expect to provide a 3- to 6-month period of orientation on the job. Furthermore, the productive graduates will continue to study throughout their careers in order to develop their total capabilities.

General Considerations

This guide has been prepared for college administrators and department heads who are seeking to determine whether or not to establish a post high school data processing program or to expand an existing program. The program design was based on extensive consultation with a committee whose membership included representatives of education and industry from across the nation. By this means initial parameters were established for technician preparation requirements. Further consultations followed with teachers, administrators, and representatives of private business. Problems, ideas, and recommendations concerning the program were brought forth, discussed, and considered. On this basis, the curriculum and supporting material were compiled and 10 technical courses were pilot tested (appendix C).

[2]Riendeau, Albert J. *The Role of the Advisory Committee in Occupational Education in the Junior College.* Washington: American Association of Junior Colleges, 1967.

American Vocational Association. *The Advisory Committee and Vocational Education.* Washington: The Association, 1969.

Institutions making use of this guide may find it desirable to undertake modifications in order to accommodate local conditions. In such cases, the advice of local advisory committees should be sought so that the modified program will be suitable to regional or local needs.

Effective teaching is essential, of course, to successful presentation of this program; but, both the necessary teaching staff and at least most of the recommended facilities and equipment should be available before the program is undertaken.

Consideration of implementing the program should begin with a comprehensive State, regional, and local area study. This can be accomplished with the assistance of people who are familiar with the areas in which data processing technology is in use or is expected to be in use. This procedure is necessary in order to determine educational needs, definite community support, evaluate available student population, and to form a basis for decision as to whether or not to offer the program. The program should not be undertaken unless there is substantial evidence that it will be required for a minimum of 10 years.

The program outlined in this guide is suitable for presentation in any of several types of post high school institutions. These include technical institutes or colleges, vocational and technical schools, 2-year community or junior colleges, and divisions of 4-year colleges or universities.

However, before the program is started in any of these schools, questions such as the following should be answered in the affirmative:

(1) Does the program represent an educational objective that the administration and staff understand and will support with personnel, funds, and cooperation?

(2) Does the program meet a need of the State or community at reasonable cost?

(3) Does the existing faculty include qualified data processing personnel or can such personnel be obtained?

(4) Will there be adequate financial support to provide the program with buildings and facilities and to maintain it by providing the proper tools, books, instruments, and equipment necessary to conduct a high quality program?

(5) Will provisions be made for an effective guidance and placement service for program graduates?

(6) Is the projected student population sufficient to justify the program?

THE CURRICULUM

Curriculum Outline

	HOURS PER WEEK			
	Class	*Lab.*	*Outside Study*	*Total*
FIRST SEMESTER				
Introduction to Computers and Programming	2	5	4	11
Communication Skills I	3	0	6	9
Business Practices	3	0	6	9
Finite Mathematics I	3	0	6	9
History of Industry	3	0	6	9
Survey of Computer Science	1	0	2	3
Total	15	5	30	50
SECOND SEMESTER				
Introduction to Accounting	3	0	6	9
Computer Operations	3	2	6	11
Communication Skills II	3	0	6	9
Finite Mathematics II	3	0	6	9
Introduction to Business Language Programming	3	3	6	12
*Special Projects	—	—	—	—
Total	15	5	30	50
THIRD SEMESTER				
Advanced Business Language Programming	2	2	4	8
Introduction to Assembly Language Programming	3	3	6	12
Computerized Accounting	3	0	6	9
Society and Working Relationships	3	0	6	9
Systems Analysis	3	3	6	12
Total	14	8	28	50
FOURTH SEMESTER				
Advanced Assembly Language Programming	2	2	4	8
Architecture of Computers and Programming	3	0	6	9
Data Base Management	3	3	6	12
Business Statistics	3	2	6	11
Business Systems Development	2	3	4	9
Total	13	10	26	49

*An elective designed to provide practical experience for students who are preparing for a career in programming; available during last three semesters.

Brief Description of Courses

FIRST SEMESTER

Introduction to Computers and Programming

An introduction to a basic computer language and flow charting, including the preparation and processing of individual programs. Operating procedures for computer systems are presented, including practical concepts of operating systems and the functional role of the central processing unit (CPU) and peripheral equipment. The student receives "hands-on" experience with the components of a modern computer system.

Communication Skills I

The first of two courses designed to enable students to communicate effectively in their occupations. Emphasis is on practical aspects of communication with considerable attention to basic communication structures.

Business Practices

An introduction to the field of business, focusing on the principles of capitalism, the methods and procedures used by businessmen to arrive at decisions, and a vocabulary of business terms. Also included are the application of bookkeeping and accounting principles and the uses of data processing in business.

Finite Mathematics I

Provides a unified treatment of several topics, including logic, set theory, and probability. The course is preparatory for the study of mathematical and logical concepts and mathematical notation required in programming and systems analysis.

History of Industry

Emphasizes the influence of American industrial and social traditions on the individual as a citizen and as a worker. Attention is focused on technological developments since 1900 and on the interactions of industry, technology, and society in the twentieth century.

Survey of Computer Science

Fundamentals of data processing vocabulary, basic descriptions of hardware and its uses, a history of hardware applications, and a survey of the functions of software. Attention is given also to the implications of future computer technology and the relationship between the computer and society.

SECOND SEMESTER

Introduction to Accounting

An introductory course for the accounting major and for the technical student who will use accounting as a tool in other fields of specialization. The approach is oriented toward problem solving, with the student required to work at least one problem or exercise for each class. Almost all laboratory assignments also are structured to emphasize problem solving.

Computer Operations

Offers "hands-on" time for the continuation and expansion of individual operations initiated in *Introduction to Computers and Programming*. On-the-job training is provided by assigning students as apprentices to site operators.

Communication Skills II

Continues from *Communication Skills I* and deals with more specific communication problems. On the premise that communication involves the individual both as sender and receiver of data, emphasis is given to improving the individual's effectiveness in these roles.

Finite Mathematics II

A unified treatment of linear algebra, Maskov chains, linear programming, game theory, and their application to problems in the sciences. The approach is different from the usual calculus-analytic geometry sequence and is particularly significant for the student whose orientation is other than physical science.

Introduction to Business Language Programming

A beginning course in business programming, emphasizing business practices and the use of a business-oriented language such as COBOL. Included are practice in the functions of the language instruction set, flow-charting, and non-scientific problem solving. File processing is limited to sequential files. The course is designed to provide business programming experience and working knowledge of a programming language.

Special Projects

Projects are designed individually for students who are preparing for a career in programming. Actual data processing problems are undertaken, and students acquire substantial work experience in applying the principles of systems analysis and design, programming in several computer languages, program testing and debugging, and program documentation.

THIRD SEMESTER

Advanced Business Language Programming

Continues from *Introduction to Business Language Programming*. Emphasis is given to formulating and solving typical data processing problems, using a business-oriented language on a digital computer. Subject areas include sorting techniques, inventory accounting, payroll calculations, and advanced language concepts and applications. Particular effort is directed to developing proficiency in making use of direct access and indexed sequential file processing, writing and linking to subprograms, sorts, and report writer.

Introduction to Assembly Language Programming

An introductory programming course or equivalent experience is prerequisite. The basic instruction set and the structure of the language are stressed. The basic assembly language set is studied in detail, but input/output (I/O) is restricted to logical level card input and to printer output.

Computerized Accounting

Concepts developed in *Introduction to Accounting* are applied by the use of data processing techniques in this course designed for accounting majors and for technical students in business-oriented data processing. In approximately equal proportion, class hours are given to lecture, demonstration, and discussion on the effective use of data processing techniques in solving problems in accounting. All laboratory assignments provide parallel problem-solving experience.

Society and Working Relationships

Illustrates how the findings of contemporary psychology and sociology can furnish man with a better understanding of himself and others, and help him to develop resources for effective living in today's world. Although emphasis is on identifying underlying principles of human development and adjustment, the course is concerned also with implications for effective personal and group behavior.

Systems Analysis

An introduction to systems terminology and analytical techniques. Topics such as coding, file organization, system design, cost analysis, and design problems are discussed. The design and methods of typical business systems are studied with emphasis placed on system organization and supporting documentation. Each student is required to design and document a simple system.

FOURTH SEMESTER

Advanced Assembly Language Programming

A continuation of *Introduction to Assembly Language Programming*. The course is designed to provide a thorough study of standard and decimal instruction sets, the Disk Operating System (DOS) assembler specifications, and the DOS IOCS MACRO systems for processing sequential, indexed sequential, and random access files. Emphasis is placed on the application of these facilities to data processing problem solving. Experience is provided in writing macros and subroutine linkages.

Architecture of Computers and Programming

Examines the fundamental principles by which computers work and how these principles affect and govern programming techniques. Surveys topics involving design and functions of computers and of programs used in them, the handling of interrupts by the computer, the design of an assembler, and the internal and external workings of the computer. Fundamental algorithms used in computing are reviewed, and attention is given to optimum data formats and representation for specific cases. The *why* of programming techniques as well as the *how* is explored.

Data Base Management

Presents the major concepts and features of data management systems. Emphasis is placed on the generalized, self-contained capabilities of data base creation and use, as opposed to more highly specialized functions. The user environment that has led to the development of data management systems (DMS) is examined; also, the relationship between DMS and the modern management information system. Most of the major topics are supported by extensive laboratory projects. A generalized hierarchical data management system is used in providing hands-on experience with generalized DMS. This system is used further as the vehicle for instruction in such subject areas as data base definition, creation, and maintenance, and for retrieval logic and the design of user systems.

Business Statistics

Offers instruction in programming a computer for solving various types of problems encountered in business. FORTRAN is used as basic programming language. The problems to which the programming techniques are applied are statistical in nature. Topics include collection, descriptive measures, index numbers, and time series analysis.

Business Systems Development

Deals with the development of problem-solving procedures prior to their computerization and with the description of these procedures by the use of flow-charts. Subject material includes characteristic flow-chart components, procedure execution, loop structure, singly subscripted variables, creation and use of subprograms, and various applications. Examples are the use of FORTRAN as a vehicle for communicating problem-solving procedures to the computer, the consideration of documented case studies in which computers have been applied to business problems, and the use of computers in business organizations. Other applications studied include sequential processing systems, characteristics and applications of real-time systems, and the implementation and operation of computer systems. Experience is given in problem definition, and in designing, coding, and testing several FORTRAN programs of increasing difficulty, both in batch and time-sharing modes.

Curriculum Content and Relationships

Functional competence in data processing is derived from at least three premises around which the curriculum must be formulated. This curriculum has been designed to develop this competence.

1. The training should prepare the graduate to be a productive employee in an entry-level job.
2. The formal program, together with a reasonable amount of experience, should enable the graduate to advance to positions of increasing responsibility.
3. The foundations provided by the training must be sufficiently comprehensive to enable the graduate to pursue further study. This study may involve reading journals, studying text materials, or enrolling in formal courses.

A 2-year program has certain unusual requirements that influence the content and organization of the curriculum. Some of these requirements are imposed by the occupational functions that graduates are expected to perform; some requirements result from the personal capabilities and objectives of the students enrolled in the program, while others develop from the limited time available to produce a competent technician in such a fluid field.

The sequence of courses in the 2-year curriculum is as crucial as the content of the courses if

the limited time available is to be used with maximum effectiveness. In general, the subject matter is coordinated carefully into groups of concurrent courses arranged to move the student smoothly from one plateau to the next. Students thus gain a deeper understanding of basic principles while broadening their grasp of the many facets of data processing. In technical curricula, it is mandatory that specialized technical course work be introduced in the first term. Deferring this introduction, even for one term, imposes serious limitations on the effectiveness of the total curriculum. Several important advantages accrue from the early introduction of the technical specialty:

1. Student interest and motivation are enhanced by practical aspects of instruction; if the first term consists entirely of general subjects (mathematics, English, social studies), students often lose interest. Since the student enrolled to study data processing, it is important to begin actual training in this area immediately.
2. Greater depth of understanding in specialized subjects is possible in the latter stages of the 2-year program if the data processing concepts have been maturing gradually over an extended period of time.
3. Students can see immediate application of the principles they study — in mathematics, business, computer language, and in the communication skills.

The relationship between laboratory time and class lecture or theoretical study time is of great importance. There must be coordination between the scientific and technical material presented in the "theory" classes and that taught in the laboratory. Laboratory work can begin when the student is acquainted only in part with the underlying theory. As the theory is taught and understood, it can be incorporated into the laboratory work.

Outside study is a significant part of the total program. In this curriculum, 2 hours of outside study time have been suggested for each hour of scheduled class time. A typical weekly schedule for a student in the first semester of this curriculum would be: class attendance, 15 hours; laboratory, 8 hours; outside study, 30 hours — a total of 53 hours per week. This is a full schedule, but it is not excessive for this type of program.

The course outlines are concise and comprehensive and are intended as guides rather than as specific instructional steps to be followed in inflexible order. Insofar as time estimates are shown, they represent a judgment as to the relative importance of each instructional unit. It is expected that principles outlined in these courses will be reinforced with business and industrial applications whenever relevant. Field trips add materially to the effectiveness of instruction if they are carefully planned in advance so that the process observed will be directly related to the subject material being studied at the time of the trip.

Beginning with the second semester and continuing through the fourth, a special projects course is available on an optional basis for students who are preparing to become career programmers. Projects are planned and assigned individually to provide maximum programming experience in a supervised, realistic work environment.

The curriculum has been designed to coincide with a semester school calendar. It can be modified for accommodation to a quarter calendar but only with considerable adjustment, including the possible restructuring of several courses. Curriculum organization is such as to permit students to select subject matter for credit transfer to other schools during both the first and the second year. In addition, they can change educational objectives to a 4-year program without extensive loss of credit.

A complete unit of instruction has been provided in both the first year and second. Since a significant program objective is to equip students with employable skills by the end of the first year, training during that period includes a balanced schedule of data processing, mathematics, business practices, and communication skills. Completion of these subjects, combined with learning systems analysis and a basic programming language, will qualify a student for many of the collateral jobs that exist in a data processing environment.

By the end of the second year, students will have learned several advanced programming languages and will have had applications courses. In addition they will have been exposed to data management systems and transmission techniques and will have had actual data processing work experience in the laboratory. Work projects are altogether realistic. Students are given problems that require them to perform a system analysis and originate a design, to prepare program speci-

fications and the program itself, to encode the program and test run it on the computer, to complete debugging procedures as required, and to document the finished program.

A balance of general education and of computer-oriented courses exists in the 2-year program. Students will enroll during both years for at least five data processing courses, each of which includes a comprehensive laboratory program emphasizing practical data processing applications. Within these parameters, a balance of programming languages has been designed. Students will learn two programming languages the first year, BASIC and COBOL, and an additional two, FORTRAN and ASSEMBLY, the second year.

Particular attention is given during the final semester to the coordination of the courses presented. Since the subject areas being studied are interrelated it is essential that instructors maintain a continuous exchange of information on the content, progress, and status of their respective courses.

Because the graduates of any program have responsibilities and interests which extend beyond their career commitments, communication and societal skills also are integrated into the total curriculum. In addition, students may challenge each course for credit by taking advanced standing examinations and thus reduce the total class hours needed to complete their program.

Suggested Continuing Study

As an element of their courses of instruction, student technicians should become thoroughly familiar with the concept that computer technology is characterized by extraordinary growth and change. As a result, they should expect and be alert to the necessity for undertaking additional formal courses of study during the course of their careers. Of course, this need can be stated accurately to apply in principle to any career field. It is uniquely pertinent to data processing technology where development has been and continues to be marked by an unprecedented rate of growth and fluidity of application. Technicians who would progress in this area must broaden the base as well as increase the depth of their specialization.

The 2-year, post-secondary curriculum must be designed and implemented to provide students with primary knowledge and skills in preparation for entering employment upon graduation. Within limits, they can acquire additional knowledge on the job by pursuing a reading program in relevant technical subjects and by participating in seminars and workshops offered by professional societies. Hardware and software vendors comprise a source of numerous extension courses dealing often with state-of-the-art technical data. In addition, many employers conduct in-house training programs designed to advance the professional development of their data processing employees. The technician should be aware, however, that only formally organized courses offer the advantages provided by systematic arrangement of subject matter, disciplined and competent teaching, and class discussions. Further, such course work can be scheduled at hours outside the working day.

Graduate technicians should select courses for continuing study that will contribute directly to their career growth. They may be well-advised to seek educational and career counseling before making this selection. Continuation or extension courses suggested generally for graduates of this program curriculum include the following subjects:

- Advanced mathematics
- Basic or advanced physical or life science subjects
- Engineering and related subjects
- Cost estimating
- Accounting
- Business administration
- Queuing techniques
- Operations research and simulation techniques

Other courses may be considered when they are recognized by local industry to be of particular value.

Cooperative Vocational Education Programs

An education program for data processing technicians is peculiarly adaptable to organized classroom and laboratory study in school, combined with carefully planned and coordinated paid employment experience in the field at appropriate intervals in the curriculum. This is commonly known as cooperative education or a cooperative program.

Cooperative programs for technicians offer special advantages to the student. Usually, they extend the length of the organized preparatory program, since they are scheduled commonly during a summer period or alternately with one or more semesters. Their principal benefit is that they provide real working practice in an environment the technician will experience after graduation. Cooperative programs make it possible for students to use the equipment and perform the processes and services required of their specialty under close supervision and with responsibility commensurate with their capabilities.

The cooperative experience must be planned and supervised carefully according to a formal agreement with the organization where the student is to work. The agreement provides for a programmed sequence of duties to be performed by the student, with supervisory responsibilities clearly defined for the educational elements of the work.

Usually two and sometimes three work experience projects, interspersed at appropriate times between school study terms, are required to obtain the best advantage for the student's learning process. The financial reward for the work can help the student meet the cost of a significant part of the educational program.

Cooperative programs keep the total curriculum up-to-date and realistic because of the necessarily close relationship with employers, insure an almost automatic and highly effective avenue for graduate placement, and provide motivation for students in the form of monetary returns while they learn their technical specialty and develop confidence in their competence on the job.

Some special administrative considerations in cooperative programs are:

1. Employment opportunities must be found with organizations sincerely interested in providing educational work experience for the student. Agreements must be negotiated for scheduled work, supervision, rates of pay, travel expenses, and performance evaluation.
2. Students must be available and ready when needed to fit into the employer's organization to perform scheduled work. When feasible, rotation schedules involving two or more students should be developed in concert with the employer's needs. Under this plan, students returning to the classroom environment are matched with students rotating to a work commitment. Ideally, one student would assume the project duties of another student who then would resume his role in the school classrooms and laboratory.
3. Supervisory and coordinative staff must be provided to plan the program and to visit, supervise, and counsel the students on the job. This work cannot be required of the staff in addition to a full-time teaching program at the school. Close supervision is required to help the students adjust to the work and meet reasonable expectations of the employer. The work situation must be evaluated realistically and never be allowed to become routine production or service work with little or no new experience in the technical specialty; it must be a learning situation as well as an earning opportunity.
4. Students should be required to do a limited amount of organized study while on the job. Often this is a daily diary of work activity, an account of the week-by-week development of some technical aspect of the job, or a detailed analysis of the progress of some project on which the student is working.
5. The employer's evaluation of students' work and attitudes must be provided, by agreement, so that it may be studied and recorded with a view to assisting the students, maintaining satisfactory cooperative relationships with the employer, and intelligently counseling students in the important elements of success in an employment situation.

A cooperative program, planned and supervised with care, can contribute significantly to the education of a competent data processing technician. Scheduled at any appropriate time, but most often during the summer months between semesters, work projects are highly variable in their characteristics; each such project is unique. For this reason, it is not feasible to present in this guide a detailed course or project outline for a cooperative program. Such programs should be developed

in accordance with local circumstances as a generic element of every education program for data processing technicians.

Cooperative programs are growing in number. Information concerning them can be obtained from National Commission for Cooperative Education, 8 West 40th Street, New York, N.Y., 10018. Departments of vocational education in State governments should be requested for data on regional and local cooperative programs.

COURSE OUTLINES

The courses which follow will outline the content to be taught in the curriculum. The materials suggested provide practical and attainable coverage of the field. They have been reviewed by experienced instructors in successful data processing educational programs and by experts representing employers of skilled data processing technicians.

It is expected that these materials will be modified in some measure. While it is necessary to meet varying needs defined by local advisory committees and to take advantage of the special interests and capabilities of the teaching staff in any particular institution, the implied level, quality, and completeness of the program should not be compromised.

At the end of each course there is a list of text and reference materials that should be analyzed for content and pertinency; new and more suitable texts and materials should be substituted when available. The information needed to cover a particular course in technician education, particularly the technical specialty courses, is almost never available in one textbook; hence, the multiple listing of references. They usually should be augmented considerably by current materials from manufacturers, trade journals, technical societies, and suppliers of apparatus and services in the special field being studied.

It is expected that the experienced instructor will make liberal use of charts, slides, models, samples, and specimens which illustrate special technical aspects of the subject. These usually are accumulated from the experience of previous laboratory or lecture preparations of the instructor and should be updated regularly when new developments require it. They are too specific for any attempt to be made to list them in this suggested guide.

The laboratory sessions suggested in the curriculum outline and in the course descriptions are not necessarily intended to be a single session but, rather, total hours of laboratory per week, to be scheduled in reasonable and effective increments. For example, a 6-hour laboratory total per week for a course might be scheduled as three 2-hour sessions or two 3-hour sessions, or any other division of laboratory time that seems appropriate.

The descriptions of laboratory exercises in this guide are only examples which represent models. They should not be interpreted as the total plan of laboratory work. The instructor is expected to design laboratory assignments according to the needs of the students and the requirements of the material, and make use of current literature and other available sources to insure the effectiveness of laboratory exercises.

INTRODUCTION TO COMPUTERS AND PROGRAMMING

Hours Per Week

Class, 3; laboratory, 2

Description

This course is intended to be the first course in the date processing curriculum, and no prior knowledge of computers or programming is assumed. The programming language, preferably BASIC or FORTRAN, and flow charting are introduced at the beginning of the course so that the student will have a better idea of what a computer does before investigating how it functions. Approximately half of the lectures and nearly all of the laboratory sessions are devoted to programming and flow charting. Programming assignments in the laboratory will run concurrently with other fundamental topics such as historical development of computers, typical present-day hardware, and software and computer applications.

Major Divisions

		Hours	
		Class	*Laboratory*
I.	Introduction to Programming	24	*30
II.	Computers Past and Present	18	2
III.	Applications and Trends	6	0
	Total	48	32

*Note: Laboratory assignments from major division I extend throughout the course.

I. Introduction to Programming
  A. Units of instruction
    1. Introduction and overview
    2. Algorithms and flow charts
    3. Elements of the language
    4. Simple programs
      a. Conversion
      b. Simple input and output
    5. Conditional statements
    6. Loops
      a. Simple loops
      b. Variable loops
      c. Nested loops
    7. Functions
    8. Arrays
      a. One-dimensional arrays
      b. Two-dimensional arrays
  B. Laboratory
    1. Tour of the computer facility. This should not be a walk-through tour by the entire class. Students should be in small groups so that all can observe the operation and function of each major hardware item in the facility.
    2. Flow charting. Practice flow charting simple algorithms, such as printing out the even integers from 0 to 100 or reading deck of cards and printing out their content. Good flow-charting techniques are to be stressed, and the correct use of flow-charting symbols should be developed.
    3. The first program. Flow chart and write a program that will perform a simple conversion table such as to convert Fahrenheit temperatures 12 through 212 degrees to centigrade equivalents at intervals of 10 degrees.
    4. Simple I/O. Flow chart and write a program that will accept numbers from the terminal or card reader and print out the number, its square root, square, and cube.
    5. Conditional statements. Flow chart and write a program that will calculate wages, given rate and time worked. Allow "time-and-a-half" for overtime.
    6. Simple loops. Rewrite the program described in paragraph 3 or modify the program described in 5 to make use of loop instructions (FOR and NEXT in BASIC or DO in FORTRAN).
    7. Loops with decisions. Flow chart and write a program to find the greatest common divisor of two integers.
    8. Variable loops. Flow chart and write a program to calculate compound interest, given the deposit, rate of interest, and the time.
    9. Nested loops. Flow chart and write a program to print out the multiplication tables 1 x 1 through 10 x 10, using nested loops.

10. One-dimensional arrays. Flow chart and write a program to assign values to the elements in a one-dimensional array, and print out the result. Example: store the first 20 numbers of the Fibonacci sequence, and print them out.
11. A closer look at computer operations. At any time after the laboratory tour, the students should be assigned on an individual "to be arranged" (TBA) basis to spend one or two hours observing and assisting an operator during a regular operation shift. Students should be allowed to step through the running of one of their respective programs in order to reinforce this process in their own minds.
12. Two-dimensional arrays. Flow chart and write a program to assign values to the elements of a two-dimensional array, and print them out.

II. Computers Past and Present
  A. Units of instruction
    1. History of computing machines
    2. History of electronic computers
    3. Numbering system
      a. Binary
      b. Hexadecimal
    4. Computer organization
      a. Central processor
        (1) Main memory
        (2) Arithmetic and logic unit
        (3) Control unit
        (4) I/O unit
      b. I/O devices
    5. Addressing
    6. Machine languages and assemblers
    7. Higher level languages
  B. Laboratory
    Practice using binary and hexadecimal arithmetic; practice converting from one number base to another.

III. Applications and Trends
  A. Applications in business
  B. Applications in science
  C. Trends in information processing
    1. In-house system
    2. Time sharing
    3. Service bureau
  D. Trends in programming languages
  E. Jobs in information processing

Texts and References

BARTEE. *Digital Computer Fundamentals.*

BOYES, SHIELDS AND GREENWELL. *Introduction to Electronic Computing: A Management Approach.*

FORSYTHE, KEENAN, ORGANICK, STENBERG. *Computer Science: A First Course.*

GERALD. *Computers and the Art of Computation.*

SPENCER. *A Guide to BASIC Programming: A Time-Sharing Language.*

STERLING AND POLLACK. *Computing and Computer Science.*

SURVEY OF COMPUTER SCIENCE

Hours Per Week

Independent study, 2

Description

This readings course supplements *Introduction to Computers and Programming* by providing a broad view of the computer and its applications. The material presented is chosen to encourage beginning students to evaluate their own career goals and to plan their future studies. A selected reading list is assigned for independent study. Students are expected to present their reactions in written reports, in individual conferences with the instructor, and in oral presentations and discussions with the class. There are no lectures and no laboratory assignments. See table 2 for a suggested weekly program.

Major Divisions

		Class Hours
I.	The Digital Villain	8
II.	Computers and Their Uses	8
III.	Expanding Use of Computers in the 70's: Markets, Needs, Technology	8
IV.	Computers and Society	8
	Total	32

I. *The Digital Villian*
- A. A view from within: the golden bit
  1. The semantics of computer science
  2. Computer pre-history
  3. Turing's mini super-computer
  4. The road to bitsville
  5. The golden bit
  6. Games computers play
  7. Playing the games
  8. Artificial intelligence and intelligent artifice
- B. A view from without: the digital villain
  1. Man as a machine
  2. Man vs. machine—the last victory
  3. The computer as an espionage agent
  4. The computer as a lover
  5. The computer as a sportsman, a moralist, and a writer
  6. The computer as the military/scientific establishment
  7. 2001: the computer as a travelling companion
  8. How the opposition sees man

II. *Computers and Their Uses*
- A. Social value of intelligent machines
- B. Evolution of data processing
  1. Organization and functions of the computer
  2. Representation of information
  3. Machine logic
  4. Algebra of automata
  5. Elements of programming
  6. Magnetic tape operations
  7. Programming techniques
- C. Symbols of human striving
  1. Conquest of the physical universe
  2. Real-time data processing
  3. Multiprogramming for real-time system
  4. Time-sharing systems
- D. Man-machine communications
  1. Computerization in the universities
  2. Role of computers in the just society
  3. Theory of automata
  4. Intelligence in the cosmos

III. *Expanding Use of Computers in the 70's: Markets, Needs, Technology*
- A. Introduction and overview
- B. Emerging requirements: what the user thinks he needs
- C. Creating new markets: the expanding role of marketing
- D. The picture overseas
  1. Needs
  2. Technology
  3. Approach
- E. Special new markets

IV. Computers and Society
- A. Why study computers?
- B. What are computers?
- C. What is their influence on society?
- D. How can we control them?
- E. What about the future?

Texts and References

BAER. *The Digital Villain.*
DESMONDS. *Computers and Their Uses.*
GRUENBERGER. *Expanding Use of Computers in the 70's: Markets, Needs, Technology.*
ROTHMAN AND MOSMANN. *Computers and Society.*

Table 2. — Survey of Computer Science, Weekly Program

(No formal classes scheduled)

Groups of students	1st wk.	2nd wk.	3rd wk.	4th wk.	5th wk.	6th wk.	7th wk.	8th wk.	9th wk.	10th wk.	11th wk.	12th wk.	13th wk.	14th wk.	15th wk.	16th wk.
	General introduction to the nature and objectives of the readings course, random assignment of track membership, and presentation of reading assignments and books															
Track 1		•	•	Written report on *Computers and Society*	•	•	Group presentation to class on *The Digital Villain*	•	•	Individual conference with instructor on *Computers and Their Uses*	•	•	Discussion among group members of *Expanding Use of Computers in the 70's*			
Track 2		•	•	Discussion among group members of *The Digital Vill...*	•	•	Written report on *Computers and Their Uses*	•	•	Group presentation to class on *Computers and Society*	•	•	Individual conference with instructor on *Expanding Use of Computers in the 70's*	General class meetings to summarize course, review books; exam if desirable		
Track 3		•	•	Group presentation to class on *Computers and Their Uses*	•	•	Individual conference with instructor on *The Digital Villain*	•	•	Group discussion of *Computers and Society*	•	•	Written report on *Expanding Use of Computers in the 70's*			
Track 4		•	•	Individual conference with instruction on *Computers and Society*	•	•	Group discussion of *Computers and Their Uses*	•	•	Written report on *The Digital Villain*	•	•	Group presentation to class on *Expanding Use of Computers in the 70's*			

COMPUTER OPERATIONS

Hours Per Week

Class, 1; laboratory, 2

Description

This course follows *Introduction to Computers and Programming* and offers hands-on experience to provide the student with a practical understanding of a computer system.[3] Operating concepts are covered in the classroom, and time in the computer center is structured to emphasize the development of specific skills and a general knowledge of sound operating procedures. It is suggested that laboratory time be scheduled so that only a few students are in the center at one time. Whenever possible, each student should be assigned as an apprentice to a site operator.

Major Divisions

		Hours	
		Class	*Laboratory*
I.	Computer Concepts	3	1
II.	Computer Devices and Operations Concepts	3	1
III.	The Operator and the Computer System	2	6
IV.	System Procedures	4	12
V.	Operating System Techniques	4	12
	Total	16	32

I. Computer Concepts
- A. Units of instruction
  1. Basic operational concepts
  2. Data recording media
  3. Storage
- B. Laboratory Projects
  Observe operations in the computer center.

II. Computer Devices and Operations Concepts
- A. Units of instruction
  1. Central processing unit
  2. I/O devices
  3. Stored program concepts
  4. Programming languages
  5. Operating system
- B. Laboratory Projects
  Demonstrate the individual hardware items in the computer center.

III. The Operator and the Computer System
- A. Units of instruction
  1. Introduction to operation
  2. Role of the operator
  3. Reader, punch, printer
  4. Tape drives
  5. Direct access devices
  6. CPU and console typewriter
- B. Laboratory Projects
  Observe and assist the operator, singly or in small groups.

IV. System Procedures
- A. Units of instruction
  1. IPL procedures
  2. LUB and PUB
  3. Job control
  4. Batch jobs
  5. Multiprogramming
- B. Laboratory Projects
  Continue assisting the operator; prepare the JCL for simple jobs, and run the jobs.

V. Operating System Techniques
- A. Units of instruction
  1. DOS run procedure
  2. Linkage editor
  3. OS run procedure
  4. Utilities
  5. Job streams
  6. POWER
- B. Laboratory Projects
  The student runs typical jobs under the supervision of regular operators and continues to observe and assist in the computer center.

Texts and References

Text and reference material consists of manufacturers' manuals on operation of the equipment with which training is conducted.

[3]Although the IBM System/360 was in use for the design and testing of this course, the course outline can be used as a guide in preparing instructional material for use with other computer systems.

INTRODUCTION TO BUSINESS LANGUAGE PROGRAMMING

Hours Per Week

Class, 3; Laboratory, 2

Description

This course is designed to improve the students' flow-charting ability and to introduce them to the COBAL language. By solving business-oriented problems assigned to them, the students are expected to develop the capability to use the COBAL language without difficulty in writing programs to process card, tape, and sequential disk files.

Major Divisions

		Hours	
		Class	*Laboratory*
I.	Review of Hexadecimal and Flow Charting	3	1
II.	Identification Division	1	1
III.	Environment Division	2	1
IV.	Data Division — File Section	6	3
V.	Data Division — Working-Storage Section	7	3
VI.	Procedure Division	6	3
VII.	Job Control Language	2	1
VIII.	COBOL Diagnostics and Debugging Features	3	3
IX.	Business Applications and Additional COBOL Specifications	18	16
	Total	48	32

I. Review of Hexadecimal and Flow Charting
  A. Units of instruction
    1. Hexadecimal numbering system
      a. Explanation and concept
      b. Decimal to hexadecimal conversion
      c. Hexadecimal to decimal conversion
      d. Addition of hexadecimal numbers
      e. Subtraction of hexadecimal numbers
    2. Flow charting
      Review
    3. General explanation of the COBOL language
      a. Overview
      b. COBOL coding sheet
      c. Reserved words
      d. Numeric literals
      e. Non-numeric literals
  B. Laboratory
    1. Solve the following:
      a. Decimal to hexadecimal conversion
      b. Hexadecimal to decimal conversion
      c. Addition of hexadecimal numbers
      d. Subtraction of hexadecimal numbers
    2. Construct a flow chart to solve a problem.
    3. Study a list of COBOL words.

II. Identification Division
  A. Units of instruction
    a. Program ID
    b. Author
    c. Installation
    d. Date written
    e. Date compiled
    f. Security
    g. Remarks
  B. Laboratory
    Write and punch the identification division for a card-to-printer inventory report. The deck should be retained for later use.

III. Environment Division
  A. Units of instruction
    1. Configuration section
      a. Source-computer
      b. Object-computer
    2. I/O section
    3. File control
      a. Select statement
      b. Assign
      c. Access
    4. I/O control
      Apply statement
  B. Laboratory
    Write and punch the environment division for a card-to-printer inventory listing. Retain the deck for use at a later date.

IV. Data Division—File Section
  A. Units of instruction
    1. File description entry
      a. FD
      b. Recording mode
      c. Label records clause
      d. Data record clause
    2. Level numbers
      a. 01
      b. 02-49
    3. Assignment of data names
    4. Picture clause

5. Types of data-usage clause
   a. External decimal or zoned decimal
   b. Packed decimal—computational-3
   c. Binary—computational
   d. Floating point—computational-1 and -2

B. Laboratory
Write and punch the file section for the inventory program started. The following fields will be in each data card: item number, quantity on hand, quantity on order, and quantity requested. (All quantity fields will be used in calculation.) Retain the deck for later use.

V. Data Division—Working-Storage Section
A. Units of instruction
1. Level 77 entries
   a. Explanation
   b. Format
   c. Value clause
2. 01 record description entries and subsequent levels
3. Report items and editing
   a. Fixed symbols
   b. Floating symbols
4. Level 88 entries

B. Laboratory
Write and punch the entire working-storage section, including 77's, and print lines for the inventory program. Allow for details for all quantity fields, and calculate the total number that should be in stock after all orders have been received and filled. Use the formula: quantity on hand + quantity on order = quantity requested. Retain the deck for later use.

VI. Procedure Division
A. Units of instruction
1. I/O statements
   a. Open
   b. Close
   c. Read
   d. Write
2. Data manipulation and arithmetic statements
   a. Move (all options)
   b. Add
   c. Subtract
3. Conditional expressions and statements
   a. Overflow test
   b. IF
4. Sequence control
   a. Stop
   b. Go to
   c. Simple perform

B. Laboratory
Using the flow chart written during the first week and the information furnished thus far, write and punch the procedure division for the inventory problem. Retain the deck and coding sheets for later use.

VII. Job Control Language
A. Units of instruction
1. Job statement
2. Option statement
   a. Link
   b. List
   c. Log
   d. Listx
   e. Sym
   f. Dump
3. Exec COBOL
4. Exec LNKTST
5. Exec LNKEDT
6. Exec
7. Miscellaneous JCL

B. Laboratory
Prepare all JCL necessary to compile the inventory program. Combine all previous decks into a single program ready for compilation; do not submit deck for a program assembly at this time.

VIII. COBOL Diagnostics and Debugging Features
A. Units of instruction
1. Explanation of diagnostics
2. Types of diagnostics
3. Debugging statements
   a. Trace
   b. On (count)
   c. Exhibit
   d. Display
4. Procedure map

B. Laboratory
Submit the inventory program for compilation; make whatever corrections are necessary until program executes correctly.

IX. Business Application and Additional COBOL Specifications
A. Units of instruction
1. Additional data division entries
   a. Block contains
   b. Record contains
   c. Redefines

d. Occurs
e. Blank when zero

2. Additional procedure division entries
   a. Rewrite
   b. Accept
   c. Display
   d. Multiply
   e. Divide
   f. Compute
   g. Relation test
   h. Sign test
   i. Class test
   j. Condition test
   k. Go to—depending
   l. Nested performs
   m. Exit
   n. Note
3. Additional job control language
   a. Assgn
   b. Tlbl
   c. Dlbl
   d. Extent

B. Laboratory

1. Write, punch, and execute a COBOL program to produce a payroll register using card input. Input cards will contain the week number, employee name and number, tax class, YTD gross, YDT FIT, QTR FICA, and gross pay. Calculate FICA and FIT, using appropriate formulas. Accumulate totals for all significant amounts.
2. Complete the processes:
   a. Write, punch, and execute a COBOL program to build a sequential disk file from card input.
   b. Write a COBOL program to list the file.
3. Write, punch, and execute a COBOL program to produce a cash transaction report, using tape input. Input will be in ascending sequence by account number by date. Take control totals by account number and date.
4. Write, punch, and execute a COBOL program that will produce an updated master file using two disk files (master and detail) as input. If the master and detail account numbers match, update the master accordingly. If a master record has no matching details, it should be retained. If a detail has no matching master, create a new master from the first detail, and update it with any subsequent matching details.
5. Complete the processes:
   a. Write, punch, and execute a COBOL program that will use as input the disk file built previously, and write selected records to tape.
   b. List the entire tape file on the printer.

Texts and References

Appropriate hardware manufacturers' manuals may be required for teaching and reference use in addition to materials that can be selected from the publications suggested below or from other sources.

CASHMAN. *Introduction to Computer Programming System/360 COBOL.*

STERN/STERN. *COBOL Programming.*

ADVANCED BUSINESS LANGUAGE PROGRAMMING

Hours Per Week

Class, 3; laboratory, 2

Description

This course, designed as a continuation of *Introduction to Business Language Programming*, utilizes more advanced concepts of COBOL, including table handling, linking programs, report writer, the internal sort, and direct access file handling. Students will be assigned numerous business-oriented problems, each requiring one or more programs.

Major Divisions

		Hours Class	Hours Laboratory
I.	Review of Basic Concepts	1	0
II.	Indexed Sequential Files	8	5
III.	Table Handling, Linking Programs, and Additional Verbs	8	4
IV.	System and Private Libraries	4	3
V.	Introduction to American National Standard COBOL	6	0
VI.	Report Writer Feature	12	10
VII.	The Cobol Sort	8	4
VIII.	Additional Problem Assignments	1	6
	Total	48	32

I. Review of Basic Concepts
   A. Hexadecimal numbering system
   B. Sequential file processing
      1. Unit-record devices
      2. Utility devices

II. Indexed Sequential Files
   A. Units of instruction
      1. Concepts
         a. Theory
         b. Need
         c. Applications
      2. Components
         a. Main data area
         b. Index area
         c. Cylinder overflow area
         d. Independent overflow area
      3. ISAM and COBOL statements
         a. Select
         b. Organization
         c. Random access
         d. Sequential access
         e. Reserve clause
         f. Record key
         g. Symbolic key
      4. Job control for ISAM files
         a. LBLTYP
         b. Multiple EXTENT(s)
   B. Laboratory
      1. Write and execute a COBOL program to retrieve selected records randomly from an ISAM file.
      2. Write and execute three COBOL programs:
         a. Build an ISAM file.
         b. Add records to the ISAM file.
         c. List the file.

III. Table Handling, Linking Programs, and Additional Verbs
   A. Units of instruction
      1. Two-dimensional tables
      2. Three-dimensional tables
      3. Additional verbs for handling tables
         a. Perform/varying
         b. Go to—depending
         c. Exit
         d. Nested performs
      4. Linking programs
         a. Enter linkage
         b. Call
         c. Enter COBOL
   B. Laboratory
      1. Write and execute a COBOL program that will link to the supplied ALC program and produce a payroll register. Card input will contain social security number, name, number of dependents, marital status, gross pay, YTD FICA, and YTD gross.
      2. Using a three-dimensional table, accumulate enrollment figures, and produce an enrollment report. Each input card contains data on 16 students. Produce a report by grade, by year, and by sex.

IV. System and Private Libraries
   A. Units of instruction
      1. Source statement library
         a. Theory

b. Uses
c. Exec maint
d. Catals C bookname
e. Bkend
f. Copy 'bookname'

2. Core image library
   a. Theory
   b. Uses
   c. Option catal
   d. Phase progname, S + O
   e. Exec progname

B. Laboratory and Semester Assignment
Design and program a complete disk-oriented payroll system that will accommodate changes, additions, time cards, and other such data. Produce monthly a list of additions, a list of changes, a payroll register, and payroll checks. After testing each program, it should be catalogued in the core image library and thereafter executed with call cards. All record descriptions should be catalogued in the source statement library. Six months of data will be run against the file. This work is to be completed one week prior to the final examination.

V. Introduction to American National Standard COBOL

A. Special registers
   1. Tally
   2. Current date
   3. Time-of-day
   4. Com-reg

B. Identification Division
   1. ID division
   2. Date compiled

C. Environment division
   1. Special names
   2. Select statement

D. Data division
   1. Pic
   2. Just
   3. Editing
   4. Comp, comp-3

E. Procedure division
   1. Implied operands
   2. Examine . . . tallying
   3. Start
   4. Write . . . advancing
   5. Write . . . positioning

VI. Report Writer Feature

A. Units of instruction
   1. Concepts
   2. Data Division considerations
      a. RD
      b. Controls
      c. Page
      d. Line
      e. Next group
      f. Type
      g. Column
      h. Group
      i. Reset
      j. Source
      k. Sum
   3. Procedure
      a. Initiate
      b. Generate
      c. Terminate
      d. Use before reporting
      e. Declaratives

B. Laboratory
   1. Using report writer, write a COBOL program to produce a simple inventory listing.
   2. Using report writer, write a COBOL program to produce a contributions report, by department.
   3. Using report writer, write a COBOL program to produce a cash transactions report using tape input. Input will be in ascending sequence by account number by date. Take control totals by account number by date.

VII. The COBOL SORT

A. Units of instruction
   1. Environment division
      Select statement
   2. Data division
      SD entry
   3. Procedure division
      a. SORT
      b. Ascending/descending
      c. Input procedure
      d. Output procedure
      e. Release
      f. Return

B. Laboratory
Write a COBOL program to build a sequential disk file using card input. Then,

using the COBOL SORT, sort the file into zip code sequence, and, using report writer, produce an address listing.

VIII. Additional Problem Assignments Laboratory

1. Write a COBOL program to reverse names. For example, John R. Smith should appear as Smith, John R.
2. Write a single COBOL program to build a sequential disk file, to sort it into a different sequence, and, using report writer, to produce an inventory listing.

Texts and References

Appropriate hardware manufacturers' manuals may be required for teaching and reference use in addition to materials that can be selected from the publications suggested below or from other sources.

BERNARD. *System/360 COBOL.*

CASHMAN. *Introduction to Computer Programming System/360 COBOL.*

FEINGOLD. *Fundamentals of COBOL Programming.*

MCCAMERON. *COBOL Logic and Programming.*

MCCRACKEN. *A Guide to COBOL Programming.*

MURRILL AND SMITH. *An Introduction to COBOL Programming.*

SPITZBARTH. *Basic COBOL Programming.*

STERN AND STERN. *COBOL Programming.*

INTRODUCTION TO ASSEMBLY LANGUAGE PROGRAMMING

Hours Per Week

Class, 3; laboratory, 3

Description

This course is intended as a first course in assembly language programming. However, the student is expected to have completed an introductory programming course or to have acquired equivalent experience prior to taking this course. The IBM System/360 DOS assembler will be used.[4] The basic assembly language set will be studied in detail, but I/O will be restricted to logical level card input and printer output.

Major Divisions

		Hours	
		Class	*Laboratory*
I.	Review of IBM S/360 Structure	3	2
II.	Introduction to IBM S/360 Machine and Assembly Language	3	2
III.	Information Move Instructions	3	3
IV.	Binary Integer Arithmetic	3	3
V.	Program Setup and Data Definition	7	8
VI.	Transfer to Control	6	8
VII.	Debugging	3	1
VIII.	Byte and Bit Manipulation	8	8
IX.	Decimal Instructions	6	10
X.	Translate and Execute Instructions	2	2
XI.	Program Status Word, Interrupts, and I/O Structure	4	1
	Total	48	48

I. Review of IBM S/360 Structure
- A. Units of instruction
  1. Number systems and conversions
     a. Decimal
     b. Binary
     c. Hexadecimal
  2. Subsystems of a stored-program computer
     a. Central processing unit
        1. Main storage
        2. Arithmetic and logic unit
        3. Control
     b. Input
     c. Output
     d. Operating system
  3. Representation of information
     a. Storage structure
        1. Binary form
        2. Boundaries—half, full, and double word
        3. Register storage
     b. Representation of binary integers
     c. Representation of characters
     d. Packed decimal representation
     e. Floating-point representation
- B. Laboratory
  1. Number conversions
     a. Decimal to binary
     b. Binary to decimal
     c. Decimal to hexadecimal
     d. Hexadecimal to decimal
     e. Binary to hexadecimal
     f. Hexadecimal to binary
  2. Represent negative binary integers in complement form
  3. Character conversions
  4. Convert from zoned decimal to packed decimal and packed to zoned

II. Introduction to IBM S/360 Machine and Assembly Language
- A. Units of instruction
  1. IBM S/360 machine language
     a. Basics
     b. Operand addressing
        1. Representation
        2. Rationale
     c. Instruction formats
        1. Operation code
        2. Operand fields
  3. Examples:
     RR RX RS SI SS
  2. IBM S/360 assembly language
     a. Basics
     b. Format of program
     c. Example of program

[4]Since the characteristics of different computer systems vary considerably, course material dealing with assembly language programming must be identified specifically with the system on which it is to be used. Although the IBM System/360 was in use for the design and testing of this course, the course outline can be used as a guide in preparing instructional material for use with other computer systems.

1. Program
2. Assembly
3. Loading
4. Execution

d. Addressing of operands
1. Symbols
2. Self-defining terms
3. Literals
4. Location counter
5. Absolute and relocatable terms
6. Expressions
7. Specifying operands in instructions

B. Laboratory
1. Compute effective addresses, given base register contents, displacement, and index register contents, if any.
2. Given a list of assembler language expressions and an indication of whether a symbol is absolute or relocatable, determine which expressions are valid. Of those that are valid, indicate whether they are absolute or relocatable.
3. Given a list of assembler language statements, the type of statements, and an indication of whether a symbol is absolute or relocatable, indicate which statements are valid.

III. Information Move Instructions
A. Units of instruction
1. Basics
2. Symbolic notation
a. R1, R2, or R3—register of first, second or third operand
b. c(R1)—contents of register
c. S1 or S2—location in main storage
d. c(S2)—contents of main storage location
e. $c(R1)_{8\text{-}31}$ of $c(S1)_{0\text{-}7}$—subscript refers to particular bits
f. I2—immediate byte of data of SI instruction
g. ♦—— act of placement
h. Example
R1 ♦—— c(R2) indicates placement of the contents of the second operand register in the first operand register.
3. Register to register (LR, LCR, LPR, and LNR)
4. Between registers and main storage
a. Load [(L, LH, LM)]
b. Store [(ST, STH, STM)]
5. Storage to storage
6. The LA instruction

B. Laboratory
1. Given the contents of registers and storage locations involved, show the result of each of the given instructions.
Example:
Given: Register 1 00000027
Register 2 000000A8
Instruction: LR 1,2
Result: Register 1 000000A8
Register 2 000000A8
2. Distinguish among the effects of the following instructions:

L	6,7
L	6,0(7)
LR	6,7
LA	6,7
LA	6,0(7)

IV. Binary Integer Arithmetic
A. Units of instruction
1. Add and subtract
2. Multiplication
a. Specifications of instructions
b. Detailed logic of the process
c. Example
d. Half-word instruction
3. Division
a. Specifications of instructions
b. Detailed logic of the process
c. Example

B. Laboratory
1. Given the contents of registers and storage locations involved, show the results of each of the given instructions.
2. Write program segments to perform assigned arithmetic.
Example: compute X as B – 5.

V. Program Setup and Data Definition
A. Units of instruction
1. The BR and BALR instructions
2. Base register setup
a. The USING pseudo-operation
b. The USING, BALR pair
c. Relocatability
3. Conversions
a. Zoned (EBC DIC) to packed decimal
b. Packed decimal to binary
c. Binary to packed decimal
d. Packed decimal to zoned (EBC DIC)
4. Definition of constants

a. Duplication factor
b. Modifiers
c. Type and value of constant
d. Alignment
e. Padding and truncation

5. The DS and EQU instructions
6. Assembler control statements
   a. START
   b. TITLE
   c. ORG
   d. LTORG
   e. END
   f. Comments card
7. DOS job control for program run
8. DTF specifications

B. Laboratory

1. Distribute and discuss an example of an assembly language program that is run on the system and is to be used in the course.
2. Assign the first program to the students. The problem should not include sophisticated logic, but should emphasize card input, printed output, simple processing, and program setup.
3. Require a flow chart of the logic.

VI. Transfer of Control

A. Units of instruction

1. Transfer
   a. Program status word
   b. Condition code
   c. Compare instructions
   d. The BC and BCR instructions
   e. Extended mnemonics
   f. Example
2. Looping
   a. Structure of loop
      (1) Body
      (2) Initialization
      (3) Incrementation
      (4) Exit
      (5) Example
   b. Programming a loop
3. Address modification
   a. Changing and testing contents of a base register
   b. Use of index registers
4. The BXH and BXLE instructions
5. The BCT and BCTR instructions

B. Laboratory

1. Assign the second program. This program should make use of fixed-point arithmetic, compare logic, conditional branching, instruction modification, and address modification.
2. Require a flow chart of the logic.

VII. Debugging

A. Units of instruction

1. Exceptions and interrupts—types and causes
2. Dumps
   a. Indicative
   b. More complete
   c. Partial
3. Error messages
4. Advance preparation
5. Trace features
6. Suggested techniques

B. Laboratory

Distribute and explain an example of a dump.

VIII. Byte and Bit Manipulation

A. Units of instruction

1. Byte manipulation
   a. Movement of data
   b. Compares
   c. Examples
      (1) Searching for a name
      (2) Character replacement
      (3) Counting digits
      (4) Generating a symbol table
2. Bit manipulation
   a. Logical arithmetic instructions
   b. Shift instructions
      1. Logical—single and double
      2. Arithmetic—single and double
   c. Logical AND and OR instructions
      1. Functions
      2. Implementation on S/360

B. Laboratory

1. Assign the third program. Bit and byte manipulation are emphasized. The concepts included are building an array in memory, changing the order of the elements in the array (sorting), and searching through the array for specific information.
2. Require a flow chart of the logic.

IX. Decimal Instructions

A. Units of instruction

1. Packed decimal representations
2. General structure of instructions
3. Add, subtract, and compare instructions

4. Moving a packed decimal field
5. Multiply and divide instructions
6. Exceptions
7. Edit instructions

B. Laboratory
1. Assign the fourth program. This program should emphasize the decimal instruction set. Computations should be done in packed decimal, and results should be edited.
2. Require a flow chart of the logic.

X. Translate and Execute Instructions
A. Units of instruction
1. Translate instructions
2. Execute instructions

B. Laboratory
Assign program segments that utilize the instructions.

XI. Program Status Word, Interrupts, and I/O Structure
A Units of instruction
1. Program status word
a. Functions
b. Instructions for manipulating the PSW
2. Interrupt handling
3. Input and output
a. Basic structure
b. Instructions
c. Status of the system
d. Channel programming
e. Interrupts and the channel status word

B. Laboratory
Discussion of information presented

Texts and References

Since an IBM System/360 was in use for the design and testing of this course outline, suggested teaching and reference materials listed below are related to that system. Manufacurers' manuals and other systems-oriented materials must be selected specifically for the equipment in use when such courses are designed.

CASHMAN AND SHELLY. *Introduction to Computer Programming IBM System/360 Assembler Language.*

CHAPIN. *360 Programming in Assembly Language.*

FLORES. *Assemblers and BAL.*

IBM. *IBM System/360 DOS Assembler Programming.*

IBM. *IBM System/360 Principles of Operation.*

IBM. *IBM System/360 System Summary.*

KAPUR. *IBM 360 Assembler Language Programming.*

STRUBLE. *Assembler Language Programming: The IBM System/360.*

SYSTEMS ANALYSIS

Hours Per Week

Class, 3; laboratory, 3

Description

This course is designed as the first course in systems analysis for data processing majors and will introduce the student to systems terminology and to analytical techniques. Topics such as coding, file organization, system design, cost analysis, and design pitfalls are discussed.

Major Divisions

		Hours	
		Class	*Laboratory*
I.	Systems Objectives and and Organizational Structure	1.5	1.0
II.	Identification Codes	3.0	2.0
III.	Forms—Input and Output	3.0	1.0
IV.	Files and Records	3.0	2.0
V.	Understanding the Present System	3.0	0.0
VI.	Decision Logic Tables	4.5	6.0
VII.	System Design	3.0	0.0
VIII.	System Documentation Techniques	1.5	2.0
IX.	Benefits and Cost Analysis	1.5	2.0
X.	System Selection	3.0	2.0
XI.	Selling the Proposed System	1.5	0.0
XII.	Installation	3.0	0.0
XIII.	System Study Techniques	1.5	2.0
XIV.	Pitfalls and Barriers	1.5	0.0
XV.	Project	13.5	12.0
	Total	48.0	32.0

I. Systems Objectives and Organizational Structure
  A. Units of instruction
    1. Broad objectives
    2. Source of revenue
    3. Role and structure of organization chart
    4. Relation of system to external influences
    5. Organization of a system department
  B. Laboratory
    Discuss and locate various types of organization structures.

II. Identification Codes
  A. Units of instruction
    1. Purposes of codes
    2. Types of codes
    3. Development of meaningful codes
    4. Field size determination
  B. Laboratory
    Develop codes to satisfy several given situations.

III. Forms—Input and Output
  A. Units of instruction
    1. Development of forms to meet the objectives
    2. Management of forms
    3. Review of forms
    4. Devices available for input and output
  B. Laboratory
    Construct forms to satisfy specific cases.

IV. Files and Records
  A. Units of instruction
    1. Composition of files
    2. File access methods
    3. Storage media available
    4. File maintenance procedures
    5. Record and block size determination
    6. File protection
  B. Laboratory
    Conduct exercises in file media selection and file development.

V. Understanding the Present System
  A. Techniques of studying the present system
  B. Documentation to be studied
  C. Identification of areas on which to concentrate
  D. Interview and observation techniques

VI. Decision Logic Tables
  A. Units of instruction
    1. Uses of decision logic tables
    2. Types of decision logic tables
    3. Construction of a decision logic table from:
      a. Narrative
      b. Flow chart
  B. Laboratory
    Practice developing decision logic tables from narratives and flow charts; interpret prepared decision logic tables.

VII. System Design
  A. Appraisal of present system

B. Selection of areas for modification
C. New system design approaches

VIII. System Documentation Techniques
A. Units of instruction
1. Use of varying degrees of detail documentation
2. Advantage of charting
B. Laboratory
Develop numerous types of documentation

IX. Benefits and Cost Analysis
A. Units of instruction
1. Methods of cost analysis
2. Forecasting benefits to be derived
B. Laboratory
Perform an exercise to develop skill in preparing a cost analysis.

X. System Selection
A. Units of instruction
1. Use of projections
2. Methods of performing system comparisons
3. Techniques to minimize compromises for the proposed system
4. Consideration of intangible benefits
5. Final selection
B. Laboratory
Practice techniques of systems comparison; identify pitfalls within the various methods.

XI. Selling the Proposed System
A. Collection of solutions to proposed problems
B. Use of visual and audio aids
C. Techniques of presenting the proposed system

XII. Installation
A. Personnel selection and training
B. Provision for the displaced employee
C. Preparation of the physical plant
D. Feasibility of parallel mode
E. Evaluation of a new system

XIII. System Study Techniques
A. Units of instruction
1. Solving data transmission problems
2. Use of:
a. PERT
b. Return on investment
c. Simulation
d. Sampling
e. Work simplication
f. Work measurement
B. Laboratory
Perform exercises in the use of PERT and in using return of investments techniques.

XIV. Pitfalls and Barriers
A. Missing management endorsement
B. Failure to communicate
C. Elusiveness of benefits to be derived
D. Resistance to change
E. Outside factors

XV. Project
A. Units of instruction
1. Introduction
2. Development
3. Presentation of results
B. Laboratory
Conduct a case study that develops all of the information presented in the course and provides an opportunity to practice the techniques studied. Students must consider forms, files, hardware capabilities, cost analysis, and other problems associated with a system analyst's work.

Texts and References

GLAMS, ET AL. *Management Systems.*
KANTOR. *Computer and the Executive.*
LOTT. *Basic Systems Analysis.*
NADLER. *Work Systems Design: IDEALS Concept.*
OPTNER. *Systems Analysis for Business Management.*

ADVANCED ASSEMBLY LANGUAGE PROGRAMMING

Hours Per Week

Class, 3; laboratory, 2

Description

This course follows *Introduction to Assembly Language Programming*. It is assumed that the students have become reasonably proficient in writing the basic assembly instructions and that their knowledge of the operating system is limited to handling card input and printer output. The intent is to provide a thorough study of IBM System/360[5] standard and decimal instruction sets, DOS assembler specifications, DOS Logical and Physical IOCS, and macro coding techniques and the application of these techniques in processing sequential and indexed sequential files. Separately assembled subroutines will be studied, written, and incorporated into the application programs. Particular attention will be given to assisting the student to achieve a sound understanding of the assembler function.

Major Divisions

		Hours	
		Class	*Laboratory*
I.	Overview and Review	12	8
II.	Sequential File Processing	3	2
III.	Linkage and Use of Separately Assembled Subroutines	6	4
IV.	Macro Writing and Use	9	6
V.	Indexed Sequential File Processing	6	4
	Sequential File Processing	3	2
VI.	Physical Level I/O	6	4
VII.	Overlays	6	4
	Total	48	32

I. Overview and Review
- A. Units of instruction
  1. The hardware system
     a. Design considerations
     b. Performance characteristics
     c. Machine instruction formats and uses
  2. A closer look at the assembler
     a. Coding conventions of the assembler
     b. The language structure
     c. Terms and expressions
     d. Addressing
  3. Review of the instruction set
     a. Fixed-point arithmetic instructions
     b. Decimal arithmetic instructions
     c. Logical operations instructions
     d. Branching instructions
  4. Reading and using core dumps
- B. Laboratory
  1. Practice coding short routines and program segments to refresh and reinforce understanding of the various types of instructions.
  2. Write a complete assembler program, to be assigned by the instructor, that will test student skill in using the various types of instruction. I/O should be restricted to card input and printer output in order to focus attention on the basic instructions.

II. Sequential File Processing
- A. Units of instruction
  1. Tape processing
     a. Physical considerations
     b. Optimum blocking guidelines
     c. Labeling conventions
  2. Sequential disk processing
     a. Physical considerations
     b. Optimum blocking guidelines
     c. Labeling conventions and the VTOC
  3. Programming considerations
     a. Logical IOCS
     b. I/O macros
     c. File creation and use
- B. Laboratory

  Write a program which will create a sequential employee wage history file. This file will be used in the programming assignments of the next two units of instruction. Input is from cards, two cards per employee, and contains name, social security number, employee number, number of dependents, and total wages for each month.

III. Linkage and Use of Separately Assembled Subroutines
- A. Units of instruction
  1. Basic concepts
     a. Advantages and when to use

[5] *Ibid.*

b. The physical relationship between the main program and the subroutine
c. Role of the software linkage program

2. Programming considerations
   a. Providing for external addresses
   b. Responsibilities of calling program
   c. Responsibilities of the called program of subroutine
   d. Preset calling conventions of COBOL or FORTRAN

B. Laboratory

Write a program that will read the employee wage history file (paragraph II) and will pass the total wages and other pertinent data to a sub-routine that will calculate and return the employee's income tax. Then, have the main program print a wage-tax report.

IV. Macro Writing and Use

A. Units of instruction

1. A macro look at macros
   a. Advantages and general use
   b. Macro vs. subroutine, which to use
   c. Cataloging and calling macros
2. A micro look at ma .os
   a. Assembler conventions for writing macros
   b. Defining the macro
   c. Different types of macros

IV. Macro Writing and Use

A. Units of instruction

1. A macro look at macros
   a. Advantages and general use
   b. Macro vs. subroutine, which to use
   c. Cataloging and calling macros
2. A micro look at macros
   a. Assembler conventions for writing macros
   b. Defining the macro
   c. Different types of macros
   d. Standard vendor-supplied macros

B. Laboratory

1. Modify the program (paragraph III) to replace the tax calculation subroutine with a macro that performs the same function.
2. Write and catalog a macro which could be useful at the involved site, such as a random number generator macro. If the assembler has the conditional assembly feature, its use should be required in the assignment.

V. Indexed Sequential File Processing

A. Units of instruction

1. File organization
   a. Software conventions
   b. Choice of index
   c. Blocking and density factors
   d. Updating and reorganization
2. Programming considerations
   a. Survey of the indexed sequential macros
   b. Creating the file
   c. Accessing and maintaining the file

B. Laboratory

1. Use the sequential wage history file (paragraph II) as input, and recreate the file as indexed sequential, using the employee number as the key.
2. Modify the tax calculation program to read the I.S. file by key, and calculate the taxes only of those whose keys are entered.

VI. Physical Level I/O

A. Units of instruction

1. Comparison of physical and logical I/O
2. Physical level macros
   a. CCB
   b. CCW
   c. The others
3. Physical I/O techniques
   a. Some basic examples
   b. Command and data chaining
   c. Error recovery

B. Laboratory

Write a program using all physical I/O which will spool cards to tape and print out the card count to the printer.

VII. Overlays

A. Units of instruction

1. Basic concepts
   a. Use and restrictions
   b. Root segment and overlay segments
2. Techniques
   a. Software conventions
   b. Optimizing the segmented program

B. Laboratory

Write a program consisting of a root and

two overlay segments. Again, the program in paragraph II can be used so that the I/O portion and tax calculation portion overlay each other as needed.

Texts and References

Since an IBM System/360 was in use for the design and testing of this course, the suggested teaching and reference materials listed below are related to that system. Manufacturers' manuals and other systems-oriented materials must be selected specifically for the equipment in use when such courses are designed.

FLORES. *Assemblers and BAL.*

IBM. *IBM System/360 Principles of Operation.*

IBM. *IBM System/360 DOS/TOS Assembler Language.*

IBM. *IBM System/360 DOS Supervisor and I/O Macros.*

SHELLY AND CASHMAN. *IBM System/360 Assembler Language Disk/Tape Advanced Concepts.*

STRUBLE. *Assembler Language Programming: The IBM System/360.*

ARCHITECTURE OF COMPUTERS AND PROGRAMMING

Hours Per Week

Class, 3

Description

This course is designed to give the student an understanding of the fundamental principles by which computers work and how these principles affect programming techniques. Numerous topics are surveyed involving the design and functions of computers and of the programs to be used with them. Also covered are the handling of interrupts, the design of an assembler, internal and external workings of the computer, several fundamental algorithms in computing, and research into the *why* of programming techniques in addition to the *how*. The student is expected to be reasonably proficient in at least one higher-level programming language and to have studied or to be studying an assembler language.

Major Divisions

		Class Hours
I.	Introduction and Overview	2
II.	Hardware	15
III.	Software	15
IV.	Simulation	6
V.	Some Important Algorithms and Techniques	10
	Total	48

I. Introduction and Overview
- A. Course scope and objectives
- B. Standards and conventions
- C. Definitions of common terms
- D. Capabilities and limitations of computers

II. Hardware
- A. The central processor
  1. Main memory
     a. Main functions and design
     b. Representation of data
     c. Addressing main memory
  2. Arithmetic and logic unit
     a. Main functions and design
     b. Registers and accumulators
     c. Zero, one, two, and three address machines
  3. Control unit
     a. Main functions and design
     b. Representation of instructions
     c. The fetch and execution cycles
     d. Tracing the execution of instructions
  4. Index registers
  5. Interrupts
     a. I/O
     b. Illegal condition
     c. Arithmetic condition
     d. Machine error
     e. Timer
  6. Comparison with IBM System/360 Processors
- B. Input/output devices
  1. Card readers and punches
  2. Paper tape devices
  3. Printers
  4. Magnetic tape devices
  5. Magnetic disk and drum devices
  6. Interfacing the I/O devices with the processor
  7. I/O buffering
  8. I/O overlapping
  9. Software for I/O
  10. Programmer I/O considerations
  11. IBM System/360 I/O systems

III. Software
- A. System software
  1. Bootstrapping
  2. A general look at an assembler
  3. Translators and interpreters
  4. Relocatable loaders
  5. Libraries
  6. The supervisor or monitor program
  7. A closer look at an assembler
  8. The IBM System/360 DOS Assembler
- B. Fundamental techniques
  1. Program loops
  2. Macros
  3. Subroutines
  4. Program organization

IV. Simulation
- A. Simulation of a computer
  1. Applicable situations
  2. Defining the model
  3. Programming considerations
  4. Simulation vs. emulation
- B. Simulation of other systems
  1. Some sample systems
  2. Logical and programming considerations

3. A simple example: writing a tick-tack-toe simulator

V. Some Important Algorithms and Techniques

A. Searching
   1. Sequential search
   2. Binary search
   3. Combination search
   4. Comparison for speed

B. Merging
   1. Two-way merge
   2. Three-way merge

C. Sorting
   a. Sequential methods
   b. Merging methods
   c. Radix methods

Texts and References

CARDENAS, PRESSER, MARIN. *Computer Science.*
FLORES. *Computer Programming System 360.*
FOSTER. *Computer Architecture.*
FREEDMAN. *Principles of Digital Computer Operation.*
GEAR. *Computer Organization and Programming.*
HELLERMAN. *Digital Computer System Principles.*
KNUTH. *Fundamental Alogrithms.*
WEGNER. *Programming Languages, Information Structures, and Machine Organization.*

DATA BASE MANAGEMENT

Hours Per Week

Class, 3; laboratory, 3

Description

Presents the major concepts and features of software systems known generally as data management systems. Emphasis is placed on the generalized, self-contained capabilities of data base creation and use, as opposed to more highly specialized functions. The user environment which has led to the development of data management systems (DMS) is examined, and the relationship between DMS and the modern management information system is explored. Most of the major topics are supported by extensive laboratory projects. A generalized hierarchical data management system is used by the student in these projects to gain hands-on experience with generalized DMS. This system becomes the vehicle for instruction in such subject areas as data base definition, creation, maintenance, retrieval, logic, and the design of user systems.

Major Divisions

		Hours	
		Class	*Laboratory*
I.	Introduction	3	3
II.	Data Storage Structures	3	3
III.	Data Access Methods	5	3
IV.	Self-Contained Logic	3	3
V.	Data Base Definition	5	6
VI.	Data Base Creation	6	6
VII.	Storage Structure and Processing Techniques	3	0
VIII.	The Retrieval Process	6	9
IX.	Maintenance	3	6
X.	Queue Processing: Batch Retrievals and Updates	3	0
XI.	Procedural Language	5	6
XII.	Design of DMS Application Systems	3	3
	Total	48	48

I. Introduction
  A. Units of instruction
    1. The concept of a generalized data base
      a. Role in the MIS approach
      b. Relationship to other files and programs
      c. Advantages and disadvantages
    2. Functions of data base management systems
      a. Data base creation
      b. File management
      c. Built-in capabilities
        (1) Simple queries and reports
        (2) Complex retrieval logic
        (3) Creation and update
      d. Interface to host languages
      e. Data base control: maintenance, recovery, security
      f. Conversational teleprocessing
    3. Survey of data management systems
      a. Attributes
      b. Hardware/software environment
  B. Laboratory
    1. Draw a general system flow chart for a personnel system using conventional data processing techniques. The system should be able to handle payroll processing as well as various listings and summaries of employee information. List the major programs, their functions, and the major files and their contents.
    2. Design a single "ideal" data base to replace the personnel files above. Briefly describe the data base contents and internal hierarchical relationships. Comment on the kinds of self-contained algorithms required to support the special-purpose queries and listings required of the data base.

II. Data Storage Structures
  A. Units of instruction
    1. Items
    2. Groups
      a. Types and attributes
      b. Relationships
    3. Entries
    4. Files
      a. Composition
      b. Characteristics
  B. Laboratory
    1. Describe a manufacturing inventory in which each entry consists of an assembly made up of several sub-assemblies, and each sub-assembly consists of many parts. Each assembly, sub-assembly, and the parts of the latter may have several attributes such as name,

number, weight, and department of origin.

2. Each student should devise a chart, using either a tree or network structure, showing how all heirarchical relationships and group membership can be established and maintained. The charts should illustrate how a given part relates to any of its assemblies or sub-assemblies.

III. Data Access Methods

A. Units of instruction

1. Sequential file access
2. Indexing methods
   a. Index generation
   b. Index maintenance
3. Inverted and partially inverted files
4. Hardware considerations

B. Laboratory

Design sequential and indexed sequential disk files for two different applications; e.g., personnel file and a geology sample file. Each entry could identify a given formation with accompanying data pertaining to a variable number of samples. Show both file layouts. Given a set of hardware and file-size parameters, compute the expected access times under each file structure for a given set of retrieval requirements. Design an overflow mechanism for handling updates. Break the geology sample file into two subfiles and recompute expected access times.

IV. Self-Contained Logic

A. Units of instruction

1. "User" language concepts
   a. Syntax requirements
   b. Program tolerances
2. Retrieval logic
   a. Syntax for print lists
   b. Qualification syntax
   c. Value search
   d. Boolean conditions: AND, OR, NOT
   e. Relational operators
   f. Special retrieval commands: macros
3. Maintenance logic
   a. Updates
   b. File control
4. Control features
   a. Security
   b. Re-start
   c. Off-line operations

B. Laboratory

1. Using the indexed sequential file already designed (paragraph III), design a language syntax that will:
   a. Print selected fields from every record in the file.
   b. Print selected fields from selected records; record qualification should have the capability for:
      (1) Equality condition on a single field
      (2) Equality condition on two fields joined by OR
      (3) Equality condition on two fields joined by AND
      (4) "Greater than" or "less than" condition on a single field.
2. Write a program to translate the syntax and imbedded conditions into procedural language steps and to retrieve data from the file. The program may be written in FORTRAN or COBOL. The program will use, as its data file, a set of commands expressed in the syntex previously designed.

V. Data Base Definition

A. Units of instruction

1. Data base structure
2. Data base components
   a. Elements
   b. Repeating groups
   c. User-defined functions
   d. Strings and extended strings
3. Inversion and partial inversion
4. Type specifications
5. Picture specification
   a. Determinging picture size
   b. Effects of picture violation
6. Repeating group relationships
7. Definition commands

B. Laboratory

1. Design a data base for the personnel application and for the geology sample file. The definitions should:
   a. Contain at least 15 components.
   b. Contain disjoint repeating groups at one or more levels.
   c. Contain some non-key fields.
   d. Be structured with at least two hierarchical levels.
   e. Use element-level security features.

2. Punch up the definitions and map them into random-access storage.

VI. Data Base Creation
- A. Units of instruction
  1. Value string format
     a. Entrance order
     b. Terminators
  2. Data value assignments
     a. Format
     b. Restrictions
  3. Data set assignments
  4. Loading macros and commands
     a. Control commands; scanning commands
     b. Load macros
  5. Loading results
     a. Loading reports
     b. Error correction
- B. Laboratory
  1. Make up "dummy" records for each of the data bases. Each data base should consist of at least 10 records with 15 or more fields.
  2. Using coding forms designed in class, code each data base into input format.
  3. Punch the input string onto cards.
  4. Load each data base previously defined with data. Report all errors encountered in loading. Report final data base sizes, load times, and other such factors.
  5. Correct any errors and re-enter data.
  6. Process a data base dump, thereby obtaining a direct printout of the entire data base.

VII. Storage Structure and Processing Techniques
- A. Internal mass storage
  1. Definition tables
  2. Value directories and multiple occurrence tables
  3. Data relationship tables
  4. Data value tables
- B. System architecture
  1. Major overlays; calling and control sequence
  2. Subroutines
     a. Functions of major subroutines
     b. Relationship of major subroutines
  3. Language package
  4. Buffer manager
  5. Paging techniques

VIII. The Retrieval Process
- A. Units of instruction
  1. General operational commands
  2. The retrieval command and object list
  3. Clauses
     a. Action clauses
     b. Qualification clauses
  4. Operators
     a. Unary operators
     b. Binary operators
     c. Tertiary operators
     d. Boolean operators
     e. AT, HAS, DITTO, SAME operators
  5. In-line functions
  6. Subtree searches
  7. Strings-usage
  8. User-defined functions
- B. Laboratory
  1. Through retrieval commands, count the valued elements of each data base.
  2. Generate formatted reports, printing out at least three components, ordering on at least two components.
  3. Structure and execute retrieval commands which will generate the following:
     a. Print the zero-level data sets for entries which contain at least two occurrences of a specified value in a lower-level repeating group.
     b. List all values which fall between a given range for a given valued element.
     c. Printout of disjoint repeating groups by qualifying on the same disjoint groups.
  4. Build and execute:
     a. Two user-defined functions
     b. Two strings

IX. Maintenance
- A. Units of instruction
  1. Groups and elements
     a. Additions
     b. Removals
     c. Changes to valued elements
     d. Unrestricted changes
  2. Trees
     a. Additions
     b. Removals
     c. Unrestricted changes
     d. Insertions
- B. Laboratory
  1. Build and execute commands using update verbs.

2. Build and execute commands using each of the tree update commands.
3. Utilize the command which rewrites selected portions of the data base onto random-access storage.
4. Update the data base with a string of valued pairs (key, value), which are accessed using the data flag and repeat options.

X. Queue Processing: Batch Retrievals and Updates

A. Queue processing concepts
1. Input handling
2. Processing efficiencies

B. Branching clauses
C. Data flags
D. Terminations

XI. Procedural Language

A. Units of instruction
1. General format of programs
2. Working-storage section statements
a. Common declarations
b. Schema statements
3. Procedure division
a. Opening and closing a data base
b. Retrieval statements
c. Qualifiers
d. Occurrence parameters
4. Positioning
a. Hierarchies
b. Position establishment
(1) Primary
(2) Secondary
(3) Current position
5. Updates
a. Insertions
b. Modifications
c. Removal of elements
d. Removal of trees
6. Diagnostics

B. Laboratory

Write a COBOL program, with imbedded procedural statements, which will use the personnel data base. For a transaction file of personnel names, salaries, and addresses, the program should:

1. Retrieve the pertinent information for each name.
2. Go to the next input record if the salary is greater than a specified value.
3. Insert a fixed address if the address field is blank.
4. Using a constant value, compute a new value if the salary is within specified limits.
5. Build the update record, and update the data base.

XII. Design of DMS Application Systems

A. Units of instruction
1. Application requirements
a. Existing programs
(1) Conversion
(2) Replacement
(3) File replacement
b. New systems
(1) Report requirements
(2) Procedural language programs
(3) *Ad hoc* requirements
(4) Future expansion
(5) Data base requirements
2. Hardware and software environment
a. Machine configuration
b. Operating system
c. Concurrent programs
d. Resource allocation
e. Teleprocessing support
f. Terminals
(1) Batch and remote batch
(2) Conversational
3. Throughput
a. Response time requirements
b. Report scheduling
c. Maintenance scheduling
d. Concurrent data base processing
(1) TP monitor function
(2) Queuing
(3) Analysis of system loading response

B. Laboratory
1. Draw a flow chart of a student registration system the way it would be implemented using a non-DMS environment. List the major programs and files. As a minimum, the system must handle the following processes:
a. Capture each student record and courses taken.

b. Handle adds and drops.
c. Post tuition receipts.
d. Reports:
   (1) Student roster by classes
   (2) Courses and teachers for any given student
   (3) Total tuition receipts by department and courses
   (4) Daily adds and drops

2. Re-draw the flow chart using the DMS approach. Define the data bases which could be used.
3. Define all entry points to the system (CRT's, batch terminals, and others), and catalogue the responsibilities, security requirements, and programming requirements necessary for each.

Texts and References

Since the topics of this course represent comparatively new technical developments, textbooks designed specifically for teaching use are not yet generally available. The materials listed below are suggested as sources of information suitable for this purpose. Other references are listed in the bibliography of this publication. It is suggested also that members of the advisory committee should be requested to recommend materials possibly available through local organizations that are operating a data base management system.

ASSOCIATION OF COMPUTING MACHINERY. *CODASYL Systems Committee Technical Report*, "A Survey of Generalized Data Base Management Systems."

DODD. *Computing Surveys* (vol. 1, no. 2), "Elements of Data Management Systems."

UNIVERSITY OF TEXAS AT AUSTIN. *Remote File Management System*. (TSD-1)

SPECIAL PROJECTS

Hours Per Week

To be arranged

Description

This special project course is designed for students who are preparing for a career in programming. They may choose to acquire the work experience the course provides as an alternative to enrollment in *Data Base Management.*

The schedule for class, laboratory, and outside work and study is flexible. Hours set out in this curriculum outline are considered minimal. Students actually may devote as many as 80 hours to a project. However, this figure is considered to be the maximum. Although formal classes are not required, instructors should schedule a period at the beginning of the semester for the purpose of orienting enrolled students. They should be informed in detail concerning the content of the course and the mode in which the program will be conducted.

Instructors will assign work projects to individual students. The work requirement is actual; the problem presented is not synthesized. Tasks are selected from those actually developed within the school, such as programming student records, business accounts, class schedules, and other similar data processing operation. Projects also are provided by local businesses and industries.

When a project is assigned to a student, the instructor in effect assumes the role of a data processing supervisor, typifying a counterpart with whom students can expect to work in a future job. In the same pattern, students are required to provide status reports, notification of problems encountered, and their plans for problem solutions. It likewise is demanded of them that the completion dates of work phases be met as scheduled.

It is essential that instructors possess the technical knowledge and experience requisite to exercising effective supervision over each student's work performance. In this respect, it virtually is mandatory that the instructor's background include several years of responsible data processing experience in business or industry.

Upon completion of their work projects, students will have had actual experience in systems analysis and design, program specification, programming in several computer languages, in program testing and debugging, and in program documentation.

Texts and References

Texts and references include all those used previously in the curriculum. In addition, extensive use is made of manufacturers' publications dealing with specific computer hardware and applications.

BUSINESS SYSTEMS DEVELOPMENT

Hous Per Week

Class, 3; laboratory, 3

Description

It is assumed that students will have been familiarized with FORTRAN (or BASIC) in the introductory course. This course will review FORTRAN (or BASIC) and then will progress to increasingly sophisticated applications that are particularly relevant to the business world. Emphasis will be placed on the development of commercial problem-solving procedures that are to be computerized and to describing these procedures by the use of flow charts. Some of the concepts to be covered are procedure execution, loop structure, subscripted variables, creation and use of subprograms and subroutines, and data storage and retrieval. Students will define, flow chart, code, and test several programs, beginning with problems that require simple reports and concluding with preparing payroll and accounts receivable programs.

Major Divisions

		Hours	
		Class	*Laboratory*
I.	Computer Problem Solving	3	3
II.	FORTRAN IV Language Elements	7	7
III.	Loops and Arrays	5	7
IV.	Specifications	2	1
V.	Subroutines and Subprograms	7	8
VI.	Debugging	2	1
VII.	Data Storage and Retrieval	8	8
VIII.	Formal Definition Framework	4	1
IX.	Business Computing Techniques	10	12
	Total	48	48

I. Computer Problem Solving
  A. Units of instruction
    1. Problem definition
    2. Flow charting
      a. Program flow chart
      b. System flow chart
    3. Programming
    4. Debugging
    5. Applying the framework
  B. Laboratory
    1. Assign a system flow chart.
    2. Describe several problems; have students write problem definitions, and develop flow charts to solve the problems.

II. FORTRAN IV Language Elements
  A. Units of instruction
    1. Basics
      a. Character sets
      b. Statement types
      c. Card format
      d. Constants and variables
      e. Operators and expressions
      f. Program termination
    2. Input/output
      a. Format
      b. Write
      c. Read
      d. Implied do
      e. Namelist
    3. Decision making and branching
      a. Unconditional GO TO
      b. Arithmetic IF
      c. Logical IF
      d. Computed GO TO
      e. Assigned GO TO
  B. Laboratory
    1. Given a list of arithmetic expressions, write them in the FORTRAN form.
    2. Assign a program that uses basic logic and accents input and output.
    3. Assign a program that implements several conditional branches.

III. Loops and Arrays
  A. Units of instruction
    1. Do and continue
    2. Arrays
      a. One-domensional
      b. Two-dimensional
      c. Three-dimensional
  B. Laboratory
    1. Assign a problem that makes use of a one- or two-dimensional array. For example, reverse the numbers in a 25-element array.
    2. Assign a problem that makes use of a two- or three-dimensional array; for example, matrix multiplication.

IV. Specifications
   A. Units of instruction
      1. Explicit type statements
         a. Integer
         b. Real
         c. Double precision
      2. Implicit statement
      3. Equivalence statement
   B. Laboratory
      Discuss topics in unit IV.A. Techniques discussed will be implemented in the programs of the other units of instruction.

V. Subroutines and Subprograms
   A. Units of instruction
      1. Predefined subroutines
      2. Assignment statement
      3. Function subprograms
      4. Subroutine subprograms
      5. Common
         a. Unlabeled
         b. Labeled
   B. Laboratory
      1. Assign a problem utilizing predefined subroutines and/or assign statement subroutines.
      2. Assign a subroutine subprogram such as computing an individual's income tax with the proper parameters given.

VI. Debugging
   A. Units of instruction
      1. Verification of programs (bench checking)
      2. Facility available
      3. Sources of information
   B. Laboratory
      Discuss topics and examples in unit VI.A. Techniques discussed will be implemented in the programs of the other units of instruction.

VII. Data Storage and Retrieval
   A. Units of instruction
      1. Sequential tape — input and output
      2. Direct access (disk) — input and output
   B. Laboratory
      Assign a tape- or disk-oriented payroll program. This should be a more complex problem typifying common techniques in the commercial world.

VIII. Formal Definition Framework
   A. Units of instruction
      1. Generic
      2. Operational
      3. FORTRAN IV statements
   B. Laboratory
      Discuss the definitions presented in order to strengthen the students' understanding of the FORTRAN IV language.

IX. Business Computing Techniques
   A. Units of instruction
      1. Sorting
      2. Merging
      3. Searching
      4. FORCOM (IBM FORTRAN commercial outlines)
         a. Floating dollar sign
         b. Alphameric move and compare
         c. Reading of unformatted records
         d. Character editing
   B. Laboratory
      1. Assign a sort of information that is stored in arrays in core or on tape or on disk. The information could be the names of customers that have accounts with a company.
      2. Assign a tape merge program. This could represent combining a new customer file with the master customer file.
      3. Search an ordered disk file for a valid customer when an item is charged to an account.

Texts and References

Appropriate hardware manufacturers' manuals may be required for teaching and reference use in addition to materials suggested below or available from other sources.

EMERICK AND WILKINSON. *Computer Programming for Business and Social Sciences.*
GOLDEN. *FORTRAN IV Programming and Computing.*
NOLAN. *FORTRAN IV Computing and Applications.*

MATHEMATICS COURSES

FINITE MATHEMATICS I

Hours Per Week

Class, 3

Description

This course of study has been designed to familiarize the student with concepts included in the broad spectrum of material encompassed by "finite mathematics." Concepts dealt with are symbolic logic, set theory, counting theory, probability, the decimal system of numeration, and systems of numeration in other bases. This course, along with the second semester (Finite Mathematics II), relates abstract theories to the formulation of mathematical models of problems and situations that arise in the social and management sciences.

Major Divisions

		Class Hours
I.	Symbolic Logic	10
II.	Set Theory	9
III.	The Decimal System of Numeration	4
IV.	Systems with Bases Other Than Ten	4
V.	Counting Theory	9
VI.	Theory of Probability	12
	Total	48

I. Symbolic Logic
- A. Mathematical systems
  1. Inductive reasoning
  2. Deductive reasoning
  3. Properties of the algebraic operations
- B. Argument validity
  1. Argument form
  2. Euler circles
- C. Statements and connectives
  1. Definitions
     a. Statement
     b. Atomic statement
     c. Compound statement
  2. Negation of statements
  3. Contrapositive
- D. Truth tables
- E. Related statements
  1. Tautology
  2. Implication
  3. Equivalent statements
  4. Inconsistent statements
- F. Properties of connectives
- G. Arguments
  1. Definition of valid argument
  2. Proof of validity
     a. Truth tables
     b. Reduction
     c. Valid argument forms

II. Set Theory
- A. Definitions and terms
  1. Set
  2. Element
  3. Subset
  4. Null set
  5. Disjoint sets
- B. Set operations
  1. Union
  2. Intersection
  3. Complement
  4. Difference
- C. Venn diagrams
- D. Properties of sets
  1. Commutative property of union
  2. Distributive property of intersection over union
  3. Laws of set algebra
- E. Boolean algebra
  1. Definition of Boolean algebra
  2. Laws of Boolean algebra
- F. Switching circuits
  1. Basic circuits
     a. Series
     b. Parallel
  2. Electrical networks
- G. Cartesian product
  1. Definition of Cartesian product
  2. Tree diagrams

III. The Decimal System of Numeration
- A. The counting or natural numbers
  1. The origin and evolution of numbers
  2. Closure
  3. Operations closed with respect to the natural numbers
     a. Addition
     b. Multiplication
- B. The real numbers
  1. Integers

2. Rational numbers
3. Irrational numbers

C. Operations and principles of real numbers
1. Addition and subtraction of signed numbers
2. Multiplication and division of signed numbers
3. Inverses and identities
a. Additive
b. Multiplicative

D. Characteristics of base ten numbers
1. Place value
2. Exponents
3. Significant digits
4. Repeating decimals
5. Non-repeating, non-terminating decimals

A. Binary numbers

IV. Systems with Bases Other Than Ten
A. Binary numbers
1. Counting in base two
2. Binary fractions

B. Conversion from base ten to base two
C. Conversion from base two to base ten
D. Binary operations
1. Addition
2. Subtraction
3. Multiplication

E. The hexadecimal system
1. Counting in base sixteen
2. Hexadecimal fractions

F. Conversion from base ten to base sixteen
G. Conversion from base sixteen to base ten
H. Hexadecimal operations
1. Addition
2. Subtraction
3. Multiplication
4. Division

V. Counting Theory
A. Number of elements in a set
B. Number of elements in the Cartesian product
C. Subsets of the Cartesian product
D. Permutations
E. Factorial and binomial notation
F. Combinations
1. Unordered partitions
2. Ordered partitions
3. Definition of combination

G. Binomial theorem
H. Binomial expansion

VI. Theory of Probability
A. Definitions
1. Sample space
2. Events

B. The axioms of probability
C. Conditional probability
1. Definition of conditional probability
2. Multiplication theorem

D. Independent events
1. Definition of independent events
2. Complete independence

E. Binomial probability model
F. Finite stochastic processes
G. Expected values
1. Means
2. Variances
3. Rules for calculating variances

H. Chebyshev's inequality
I. The law of large numbers
J. Markov chains
1. Classification of states
2. Regular chains
3. Absorbing chains

Texts and References

BOSSTICK AND CABLE. *Patterns in the Sand.*
KATTSOFF AND SIMONE. *Finite Mathematics.*

FINITE MATHEMATICS II

Hours Per Week

Class, 3

Description

This course is a continuation of *Finite Mathematics I* and an introduction of essential topics in the study of calculus. Taken individually, the topics provide useful models of problems arising from a veriety of sources. Collectively, they represent a reservoir of concepts that can be amended or combined to serve as models for problems not yet formulated.

Major Divisions

		Class Hours
I.	Relations and Functions	3
II.	Linear Inequalities	6
III.	Non-Linear Functions	9
IV.	Systems of Linear Equations	6
V.	Matrices	9
VI.	Linear Programming	6
VII.	Sequences	3
VIII.	Infinite Series	6
	Total	48

I. Relations and Functions
- A. Ordered pairs of numbers
  1. Notation
  2. Definition of equality
- B. Cartesian coordinate system
- C. Definition of relation
  1. Notation
  2. Graphs of relations
  3. Describing relations by equations
- D. Definition of function
  1. Functional notation
  2. Domain and range
  3. Describing functions by equations
- E. Linear functions
  1. General forms
  2. Graphs of linear functions
  3. Slope; y-intercept

II. Linear Inequalities
- A. Definition of inequality symbols
- B. Linear inequalities in one variable
  1. Properties
  2. Graphs of linear inequalities in one variable
- C. Linear inequalities in two variables
  1. Properties
  2. Graphs
- D. Graphing sets of linear inequalities in a single coordinate system

III. Non-Linear Functions
- A. Quadratic functions
  1. Graphs
  2. Forms
  3. Concavity
  4. Maximum and minimum
  5. Applications of maximum and minimum
- B. Quadratic equations
  1. Solutions
     a. Factoring
     b. Completing the square
     c. Quadratic formula
  2. Complex numbers
  3. Complex solutions
- C. Trigonometric functions
  1. Angle
     a. Initial side
     b. Terminal side
     c. Standard position
  2. Definition of trigonometric function
  3. Reciprocal relations
  4. Fundamental identities
  5. Use of the trigonometric tables for acute angles
- D. Logarithmic functions
  1. Definition of logarithmic function
  2. Graphs of log functions
  3. Properties
  4. Common logarithms
  5. Natural logarithms
  6. Use of common log tables
  7. Computation with logarithms

IV. Systems of Linear Equations
- A. Graphical solution
  1. Systems in two variables
  2. Systems in three variables
- B. Linear combinations
- C. Solution by substitution
- D. Definition; m x n system
  1. Elimination procedures: $m = n$
  2. Elimination procedures: $m > n$
  3. Elimination procedures: $m < n$
  4. Canonical procedure

V. Matrices
- A. Definition of a matrix
- B. Terminology
  1. Notation

2. Order
3. Column matrices
4. Row matrices
5. Zero matrices

C. Elements of matrix algebra
1. Equality of matrices
2. Addition of matrices
3. Subtraction of matrices
4. Product of a scalar and a matrix
5. Product of matrices

D. Linear systems in matrix notation

E. Inverse of a square matrix
1. Identity matrix
2. Elementary row and column operations

F. Matrix solutions of linear systems

VI. Linear Programming

A. Introductory example: two variables
1. Objective function
2. Constraints
3. Graphical aids

B. Three variable case

C. Stated problems

VII. Sequences

A. Definition of a sequence as a function
1. Domain
2. Range

B. Notation

C. Definition of the limit of a sequence
1. Convergence
2. Divergence

D. Arithmetic sequences
1. n^{th} term
2. Sum of the first "n" terms

E. Geometric sequence
1. n^{th} term
2. Sum of the first "n" terms

VIII. Infinite Series

A. Definition of infinite series

B. Summation notation

C. Convergence and divergence

D. Infinite geometric series
1. Conditions for convergence
2. Computation of sum

Texts and References

FULLER. *Plane Trigonometry and Tables.*
KATTSOFF AND SIMONE. *Finite Mathematics.*
OWEN AND MUNROE. *Finite Mathematics and Calculus.*

BUSINESS STATISTICS

Hours Per Week

Class, 3; laboratory, 2

Description

This course is designed to present to the student the information required in order to solve business-oriented problems, using a computer. The computer language to be taught and used is FORTRAN IV. The primary types of problems to be solved are statistical in nature and include data collection, descriptive measures, index numbers, and time series analysis.

Major Divisions

		Hours	
		Class	*Laboratory*
I.	Collection and Tabulation of Data	5	1
II.	Basic Elements of FORTRAN	8	5
III.	Statistics Tables and Charts	3	1
IV.	Statistical Description—Averages	5	4
V.	Statistical Dispension	3	4
VI.	Probability and Sampling	5	1
VII.	FORTRAN Data Arrays	4	2
VIII.	Time Series and Trends	5	6
IX.	Statistical Variations	3	5
X.	FORTRAN Functions and Subroutines	4	2
XI.	Index Numbers	3	1
	Total	48	32

I. Collection and Tabulation of Data
- A. Units of instruction
  1. Basic definitions
     - a. Statistic
     - b. Statistical data
     - c. Population
     - d. Sample
     - e. Parameter
     - f. Statistical pitfalls
     - g. Bias
     - h. Trends
  2. Internal and external data
     - a. Differences
     - b. How collected
     - c. Problems of collection
     - d. Sample surveys versus complete enumerations
  3. Methods of collecting statistical data
     - a. Observation method
     - b. Questioning methods
     - c. Forms taken by facts
     - d. Design of questionnaires
  4. Use of data processing for statistical applications
     - a. Concept of computer operations
     - b. Unit records
     - c. Computer calculations
- B. Laboratory

  Design a questionnaire to determine how students take tests (physical motions) and their attitudes toward taking a test from a computer.

II. Basic Elements of FORTRAN
- A. Units of instruction
  1. Kinds of numbers
     - a. Integer
     - b. Real
     - c. Floating point
  2. Variables and constants
     - a. Naming conventions
     - b. Mode
  3. FORTRAN coding form
     - a. How used
     - b. Explanation of boundaries
  4. Input and output
     - a. READ
     - b. WRITE
     - c. FORMAT
     - d. Notations (F, I, X, T, and H)
  5. Program control
     - a. GO TO XX
     - b. Arithmetic IF statement
  6. Assignment statements
     - a. Modes
     - b. Evaluation of expressions
     - c. Storage of variable values
  7. Logical variables
     - a. Logical assignment statement
     - b. Logical IF statement
  8. The DO statement
     - a. Nature of command
     - b. Nesting
     - c. Rules for use
- B. Laboratory

  Write FORTRAN programs to:
  1. Compute and print a frequency distribution from card input. Each card con-

tains the year and frequency of occurrence. Print a total of all occurrences.

2. Compute and print a frequency and cumulative frequency distribution from card input. Each card contains a percentage level. As each card is read, a determination of proper group is made, and one is added to its occurrence counter.

   Example: Card data 72.3

   Assume proper class interval is 70-79.

   Therefore: add one to the accumulation for this class and go read the next card. Print a total of all occurrences.

III. Statistics Tables and Charts
   A. Units of instruction
      1. Classifications
         a. Differences of kind
         b. Differences of degree
         c. Geographic differences
         d. Temporal differences
         e. Time series
      2. Charts
         a. Bar
         b. Semilogarithmic
         c. Logarithmic
         d. Line
         e. Component parts
         f. Pie
         g. Statistical maps
   B. Laboratory
      Given a set of statistical data, draw a bar chart, a pie chart, and a line chart for the data.

IV. Statistical Description—Averages
   A. Units of instruction
      1. Uses of averages
         a. Common denominator
         b. Measure of typical size
      2. The principal averages
         a. Arithmetic mean
         b. Geometric mean
         c. Harmonic mean
         d. How to compute the above
      3. Other measures
         a. Median
         b. Mode
   B. Laboratory
      Write a FORTRAN program to compute the arithmetic mean, geometric mean, and the harmonic mean of a set of data.

Arithmetic mean: $\mu = \frac{\sum x}{N}$

Harmonic mean: $H = \frac{N}{\sum \frac{1}{x}}$

Geometric mean: $\log G = \frac{\sum \log x}{N}$

V. Statistical Dispersion
   A. Units of instruction
      1. Importance of dispersion
      2. Measures of dispersion
         a. Range
         b. Quartile deviation
         c. Average deviation
         d. Standard deviation
         e. Variance
         3. Computational methods
      4. Skewness
      5. Kurtosis
   B. Laboratory
      Write a FORTRAN program to compute the standard deviation from a frequency distribution.

$$\sigma = \sqrt{\frac{\sum f(d')^2}{N} - \left(\frac{\sum fd'}{N}\right)^2} = \text{standard deviation}$$

VI. Probability and Sampling
   A. Units of instruction
      1. Distributions
         a. Normal
         b. Poisson
         c. Geometric
         d. Binomial
      2. Probabilities
         a. Addition
         b. Multiplication
      3. Curve fitting
   B. Laboratory
      1. Consider the following: A manufacturer believes 95 percent of the items turned out by his plant will pass inspection. If this is true, what is the probability that one or less will be defective in a sample of eight items?
      2. Consider the following: A river has a

damaging flood on the average of once every 10 years. What is the probability of not having a flood in a given 10-year period? Of having one flood in the period? Two floods? More than two floods?

VII. FORTRAN Data Arrays
- A. Units of instruction
  1. Array elements
  2. Subscripts
  3. DIMENSION statement
     a. Number of subscripts
     b. Types of arrays
     c. Assigning values
  4. Matrix notation and use
- B. Laboratory
  Write a FORTRAN program to multiply two compatible matrices, one input card per matrix.

$$[A] \cdot [B] = [C]$$

VIII. Time Series and Trends
- A. Units of instruction
  1. Types of fluctuation
     a. Secular
     b. Seasonal variation
     c. Cylical fluctuations
     d. Random or erratic fluctuations
  2. Time series analysis
     a. Problems
     b. Correlation analysis
     c. Adjustments
     d. Relatives
  3. Straight line trend
     a. Graphic method
     b. Semi averages
     c. Least squares
- B. Laboratory
  Write a FORTRAN program to compute the straight-line trend line equation from a set of data.
  $Y = a + bx$ (equation of line)
  Analyze results and discuss.

IX. Statistical Variations
- A. Units of instruction
  1. Indexes of seasonal variation
     a. Measurement — A
     b. Specific seasonals
  2. Ratio of the 12-month moving average
- B. Laboratory
  Write a FORTRAN program to compute the 12-month moving total and 12-month moving average centered on the 7th month for a 12-year set of data. Use arithmetic mean:

$$\mu = \frac{\sum x}{N}$$

  Why is the moving average centered on the 7th month?

X. FORTRAN Functions and Subroutines
- A. Units of instruction
  1. Internal function
     a. Calling the function
     b. Defining the function
  2. External function
     a. Structure
     b. Purpose
     c. Significance
  3. Subroutines
     a. Calling subroutines
     b. Identifying subroutines
     c. Specification statements
- B. Laboratory
  Expand the FORTRAN program required in paragraph IX.B. by having the program produce a report by month (columns) by increasing order of value within columns of the data. Use a function or subroutine in the program.

XI. Index Numbers
- A. Units of instruction
  1. Nature of index numbers
     a. Simple relatives
     b. Averages of relatives
     c. Means of relatives
  2. Problems
     a. Averages
     b. Weights
- B. Laboratory
  Compute the geometric relatives for a given exercise. What do these results physically show?

Texts and References

FREUND. *Statistics, A First Course.*
HOEL AND JENSEN. *Basic Statistics for Business and Economics.*
MASON. *Statistical Techniques in Business and Economics.*
STOCKTON AND CLARK. *Business and Economic Statistics.*
STUART. *FORTRAN Programming.*

Auxiliary and Supporting Courses

BUSINESS PRACTICES

Hours Per Week

Class, 3

Description

This course introduces the student to the world of business and examines the role of business in our complex society. The course is designed to develop the student's ability to think, to reason, to analyze problems, and to make decisions.

This introductory course also fulfills the objectives of building a vocabulary of business terms, surveying the field of business administration, explaining the free enterprise system, and helping the students decide where they may find a career in the business world.

Major Divisions

		Class Hours
I.	Business and Society	7
II.	Ownership, Organization, and Management	6
III.	Marketing	8
IV.	Personnel	5
V.	Production	3
VI.	Finance	8
VII.	Quantitative Controls	6
VIII.	Legal and Regulatory Environment of Business	5
	Total	48

I. Business and Society
- A. Business career opportunities
  1. Occupational selection data
  2. Areas of employment opportunities
  3. Vocational decision making
- B. Nature of business
  1. What is capitalism?
  2. Characteristics of present-day business
  3. Size of business firms
  4. Classification of business
  5. Other economic systems
  6. Business terms
- C. Economic business environment
  1. Historical setting
  2. The multifaceted environment of business
  3. Change as an environmental ingredient
  4. Environmental trends
  5. Business terms
- D. Ethics and social responsibilities
  1. Business ethics
  2. The social responsibility of business
  3. Business terms

II. Ownership, Organization, and Management
- A. Unincorporated businesses
  1. Sole proprietorships
  2. Partnerships
  3. Other unincorporated forms of business ownership
  4. Business terms
- B. Incorporated business
  1. Corporations
  2. Other incorporated businesses
  3. Business terms
- C. Organization and management
  1. Organizational process
  2. Forms of organizational structure
  3. Theories of organization
  4. Organizational effectiveness
  5. Business terms
- D. Management activities
  1. Decision making
  2. Management functions
  3. Managerial leadership
  4. Managerial performance
  5. Business terms

III. Marketing
- A. Marketing—nature and scope
  1. The role of marketing
  2. Basic types of economic goods
  3. Marketing functions
  4. A typical manufacturer's sales organization
  5. Marketing strategy
  6. The consumer
  7. Business terms
- B. Wholesaling and retailing
  1. Channels of distribution
  2. Wholesaling
  3. Retailing
  4. Business terms
- C. Prices and pricing
  1. Approaches to price determination
  2. Price determining factors
  3. Price in relation to supply and demand
  4. Business terms

D. Advertising
   1. Types of advertising
   2. Advertising media
   3. The advertising agency
   4. Advertising in the small business
   5. Is advertising effective?
   6. Criticisms of advertising
   7. Ensuring truth in advertising
   8. The Advertising Council
   9. Business terms

E. International trade
   1. Why nations trade
   2. Characteristics of international trade
   3. Role of the United States in world trade
   4. International arrangements for trade and payments
   5. Business terms

IV. Personnel

A. Employee selection and training
   1. Nature and background of the problem
   2. The personnel department—structure and functions
   3. Business terms

B. Employee compensation
   1. Conceptual bases of wages
   2. Variations in wages
   3. Wage incentives
   4. Methods of wage payment
   5. Employee benefits
   6. Wage and salary administration
   7. Business terms

C. Labor problems and legislation
   1. Growth of organized labor
   2. Bargaining tactics and settlement of disputes
   3. Types of unions
   4. Labor legislation
   5. Business terms

V. Production

A. Materials management
   1. Purchase of materials
   2. Handling and control of materials
   3. Purchase and control of mechandise
   4. Inventory control in manufacturing
   5. Inventory control in wholesaling and retailing
   6. Transportation
   7. Business terms

B. Production problems
   1. Key decisions in production
   2. Manufacturing processes
   3. Recent developments in production
   4. Research and production
   5. Production management
   6. Business terms

VI. Finance

A. Short-term financing
   1. Types of capital
   2. Advantages of short-term financing
   3. Short-term obligations
   4. Financial institutions—short-term capital
   5. Business terms

B. Long-term financing
   1. Debt and equity capital
   2. Non-corporate and corporate long-term financing
   3. Bonds
   4. Stocks
   5. Financial institutions—long-term capital
   6. Business terms

C. Financial problems and policies
   1. Capital structure
   2. Distribution of earnings policies
   3. Allocation of funds
   4. Business combinations
   5. Failures and reorganizations
   6. Business terms

D. Security markets and financial news
   1. Security exchanges
   2. Over-the-counter markets
   3. Regulation of security sales
   4. Financial news
   5. Business terms

E. Risks and insurance
   1. Business risks
   2. The insurance business
   3. Property and liability insurance
   4. Health insurance
   5. Life insurance
   6. Business terms

VII. Quantitative Controls

A. Accounting and financial statements
   1. Importance of accounting
   2. Types of accountants
   3. Accounting procedures
   4. Business terms

B. Data processing
   1. Nature of data processing
   2. History and importance of data processing
   3. Types of computers
   4. The binary code

5. Components of a computer
6. Computer hardware
7. Computer software
8. Flow charts
9. The systems concept
10. Computer-based services
11. Future role of computers
12. Business terms

C. Business statistics and reports
1. Business statistics
2. Business reports
3. Business terms

D. Forecasting and budgeting
1. Forecasting
2. Budgeting
3. Operations research
4. Business terms

VIII. Legal and Regulatory Environment of Business

A. Business law
1. Legal systems
2. Torts and crimes
3. Legal procedures
4. Types of courts
5. Scope of business law
6. Business terms

B. Governmental regulation of business
1. Distinction between competitive businesses and regulated industries
2. Regulation of competitive business
3. Regulated industries
4. Business terms

C. Business and taxes
1. Principles of taxation
2. Types of state and local taxes
3. Types of federal taxes
4. Taxation and business decisions
5. Business terms

Texts and References

BUSKIRK, GREEN, AND RODGERS. *Concepts of Business.*
GLOS AND BAKER. *Business: Its Nature and Environment.*
GLOS AND BAKER. *Student Manual* (to accompany *Business: Its Nature and Environment).*
ROSS. *Business in a Free Society.*

HISTORY OF INDUSTRY

Hours Per Week

Class, 3

Description

This course focuses on the information of society and technology, primarily in the 20th century, but also with some historical background and development. The topics range from communications to agriculture to cybernetics, and provide students with an enlarged perspective of the role of technology in their daily lives and the impact it may exert upon them in the future.

Major Divisions

		Class Hours
I.	Science, Technology, and Society	12
II.	Automation—A Creation of the New Technology	12
III.	The New Technology and Emerging Issues	12
IV.	Science, Technology and the Policy-Making Process	12
	Total	48

I. Science, Technology, and Society
- A. The impact of scientific or technological change: an historical perspective
  1. The two cultures and C. P. Snow
  2. The ethical influence of machinery on labor
  3. "The Superstitions of Science" (Tolstoy. *The Arena.*)
- B. Science, society, and human values
  1. Some problems of science and values
  2. "The Idols of the Laboratory" (Krutch. *The Measure of Man.*)
  3. Conflicts between science and religion
- C. Education in a technological era
  1. Education for 11 children
  2. Automation of knowledge

II. Automation—A Creation of the New Technology
- A. The nature of computers and automation
  1. The nature of automation
  2. Origins of the computer
  3. Man-machine partnership
  4. The impact of mass communication
- B. Transportation
  1. Internal-combustion engine
  2. Rail and water transport
  3. Development of aviation
- C. Materials and structures
  1. Man-made materials
  2. Steel and concrete construction
  3. The home environment
- D. Automation and society: the problem of employment
  1. Cybernation
  2. Automation and unemployment
  3. The social effects of mass production
- E. Automation and society: the problem of leisure
  1. "Labor, Leisure, and the New Class" (Galbraith. *The Affluent Society.*)
  2. "The Crisis of Abundance" (Theobald. *Technology in Western Civilization.*)

III. The New Technology and Emerging Issues
- A. Population and resources
  1. Overpopulation
  2. Social factors of fertility regulation
  3. The politics of ecology
     a. Carson. *The Silent Spring.*
     b. Man and natural selection
  4. The prospects of genetic change
- B. Land use and resources
  1. Regional planning and development
  2. Urban planning and development
- C. The food revolution
  1. Scientific agriculture
  2. Mechanization of the American farm
  3. Pest and disease control
  4. "Freedom and the Control of Men" (Skinner. *The American Scholar.*)

IV. Science, Technology and the Policy-Making Process
- A. Science and government
  1. Science and national priorities
  2. NASA and the space program
  3. "Soviet Science—a Survey" (Rabinowitch in *The New Technology and Human Values.* Burke.)
- B. Technology in war
  1. Mechanization of war: 1880-1919
  2. Three-dimensional warfare: World War II

3. Contemporary spectrum of war
4. Transfer of military technology to civilian use

C. Space, culture, and technology
   1. The challenge of space
   2. "Science, Scientists, and Politics" (Michael. *Science, Scientists, and Politics.*)

D. The new technology and the future of democracy
   a. Christians confront technology
   b. The era of radical change

Texts and References

BURKE. *The New Technology and Human Values.*
CARSON. *The Silent Spring.*
KRANZBERG AND PURSELL. *Technology in Western Civilization.*
SNOW. *The Two Cultures and a Second Look.*

INTRODUCTION TO ACCOUNTING

Hours Per Week

Class, 3; laboratory, 2

Description

This course is designed as an introductory course for the accounting major and for the technical student who will use accounting as a tool in other fields of specialization. The approach is oriented toward problem solving with the student working at least one problem or exercise for each class meeting. Almost all of the laboratory assignments involve problem solving, and about one-third of the lecture series is spent in demonstration problems. The remaining lecture time is used to discuss accounting theory, procedures, techniques, and application.

Major Divisions

		Hours	
		Class	*Laboratory*
I.	Introduction to Accounting —Its Concepts and Elementary Procedures	12	8
II.	Developing Accounting Records That Will Work for Management	9	6
III.	Major Accounting Considerations and Problems for the Beginning Student	8	12
IV.	Accounting Systems	9	6
	Total	38	32

I. Introduction to Accounting—Its Concepts and Elementary Procedures
   A. Units of instruction
      1. Introduction and overview
      2. The work of an accountant
      3. Accounting statements
         a. Income statement
         b. Balance sheet
      4. Mechanics of double entry accounting
      5. Recording accounting transactions
      6. Posting accounting transactions
      7. The need of adjusting entries and the matching principle
      8. The accounting worksheet
   B. Laboratory
      1. View of the film *Men of Accounting* as an introduction to accounting.
      2. Assign problems that will give students the following accounting experience:
         a. Preparing an income statement and balance sheet from data provided
         b. Recording transactions to show their effects on the accounting equation
         c. Recording transactions in general journal form
         d. Posting transactions from the general journal to the general ledger
         e. Preparing adjusting journal entries at the end of an accounting period
         f. Preparing an accounting worksheet

II. Developing Accounting Records That Will Work for Management
   A. Units of instruction
      1. Providing an accounting system for a merchandising business
      2. Introduction to business papers in a mechandising business
      3. The use of columnar journals in accounting records
      4. The use of subsidiary ledgers in accounting records
      5. Internal control and its goal
      6. Business forms and internal control
      7. The voucher system
   B. Laboratory
      Assign problems that provide the following experiences:
      1. Preparing an income statement for a merchandising business
      2. Using and posting the four fundamental special journals
      3. Using subsidiary accounts; general ledger control
      4. Evaluating internal control in a business
      5. Recording entries in a voucher register

III. Major Accounting Considerations and Problems for the Beginning Student
   A. Units of instruction
      1. The control of cash
      2. The control of accounts receivable
      3. Promissory notes of interest
      4. Accounting for discounted notes
      5. Accounting for inventory
         a. Assigning a cost
         b. Elements of inventory
      6. Accounting for plant and equipment
      7. Depreciation and the fixed asset
         a. Allocating depreciation

b. Recording depreciation
8. Accounting for natural resources and intangible assets
9. Accounting for repairs, replacements, and betterments
10. Payroll accounting

B. Laboratory
Assign problems that will provide the following experiences:
1. Using petty cash fund
2. Reconciling a bank account
3. Using direct write-off method and allowance method in handling bad debts
4. Aging of accounts receivable
5. Recording journal entries to discounting a note receivable including all computations
6. Assigning a cost to an ending inventory at least the following methods:
   a. Specific invoice identification
   b. Weighted average
   c. First in, first out
   d. Last in, first out
7. Using a perpetual inventory system
8. Using the gross profit and retail method to estimate inventories
9. Allocating depreciation using at least the following methods:
   a. Straight-line method
   b. Units of production method
   c. Declining balance method
   d. Sum of the years digits method
10. Developing and using plant asset records
11. Preparing a payroll register

IV. Accounting Systems
A. Units of instruction
   1. Manual data processing
   2. Mechanical data processing
   3. Electronic data processing
B. Laboratory
   1. Review accounting systems in use by area businesses.
   2. Complete the computerized accounting problem.

Texts and References

HORNGREN. *Accounting for Management Control.*
PYLE AND WHITE. *Fundamental Accounting Principles.*
PYLE AND WHITE. *Work Papers* (for *Fundamental Accounting Principles).*
SALMONSON, HERMANSON, AND EDWARDS. *Survey of Basic Accounting.*

COMPUTERIZED ACCOUNTING

Hours Per Week

Class, 2; laboratory, 3

Description

This course, designed for accounting majors and for technical students in business-oriented data processing, demonstrates how the concepts developed in *Introduction to Accounting* are applied by the use of data processing techniques. In approximately equal proportion, class hours are given to lecture, demonstration, and discussion on the effective use of data processing techniques in solving problems in accounting. All laboratory assignments provide parallel problem-solving experience.

Major Divisions

		Hours	
		Class	*Laboratory*
I.	System Fundamentals	6	8
II.	Data Processing Equipment	6	8
III.	Accounting Techniques and Computer Applications	8	16
IV.	Business Procedures and Applications Processes	12	16
	Total	32	48

I. System Fundamentals
- A. Units of instruction
  1. Internal business organization structure
  2. The systems department
  3. Systems communications and instruction manuals
  4. Forms management and records retention
- B. Laboratory
  1. Conduct field trips to local organizations that use computers or data processing.
     a. Identify organizational management structures
     b. Survey forms management, utilization of user instructional manuals,and records retention practices.
  2. Assign the following problems:
     a. Prepare an organizational chart of alternative types of internal management structures relatives to data processing operations.
     b. Prepare a module of a user instruction manual for a specific application.
     c. Prepare a form layout for an accounting application and explain the use of the form.

II. Data Processing Equipment
- A. Units of instruction
  1. Review of functions and capabilities
     a. Various types of unit record equipment
     b. Computers and peripheral equipment
  2. Relationship of basic accounting systems and procedures to unit record and computer equipment
- B. Laboratory
  1. Demonstrate:
     a. Capability and use of various types of computer and unit record equipment in the accounting cycles
     b. Fundamentals and techniques of batch balancing, cross footing, and statement production used in the preparation of accounting statements.
  2. Provide machine accounting experience, using unit record or computer equipment.
     a. Prepare specialized journals.
     b. Prepare reports:
        (1) Batch balancing
        (2) Cross footing different types of statements
     c. Prepare a profit and loss statement and supporting statements, using data and programming materials provided.
     d. Prepare written procedures to be used in developing a profit and loss statement, identifying specific cross reference points to be checked for balancing purposes.

III. Accounting Techniques and Computer Applications
- A. Units of instruction
  1. Relationship of accounting procedures and charting data flow
  2. Methods of coding and condensing data

3. Design of data input records, such as cards, direct data input, and key tape
4. Forms design

B. Laboratory
Problems:
1. Relate specific job requirements in the accounting cycle to data processing or computer operations procedures.
2. Prepare flow charts for an accounts receivable function including:
   a. Source or sources of data
   b. Internal control procedures for verification
   c. Data reduction and verification prodess
   d. Machine room processing
   e. Distribution of output,including specialized journals, billing, statements, and reports
3. Prepare instructions and procedures identifying techniques to be used in coding and condensing data for reduction and input.
4. Prepare card format and record format for other data input devices relative to requirements of a specific accounting function, such as payroll.
5. Prepare computerized accounting forms, machine-oriented and printed, for special journal, interim, quarterly, and annual statements.

IV. Business Procedures and Application Processes
A. Units of instruction
1. Review of accounting cycle functions
2. Business processes most readily adaptable to computer
3. Internal and machine room control procedures required for effective business system processing

B. Laboratory
Solve problems that will provide experience in identifying specific functions in the accounting cycle that have machine applications.
1. Functions: purchasing and receiving; applications: purchasing and receiving
2. Function: materials control; application: materials control
3. Function: production control; application: production control
4. Functions: product distribution and billing; application: billing
5. Functions: accounts receivable and collections; application: accounts receivable
6. Functions: disbursement and distribution; applications: accounts payable and payroll

Texts and References

BURGLY AND RANDALL. *Systems and Procedures for Business Data Processing.*

DEVLIN, MORRISON, AND NOLAN. *Work Measurement in Machine Accounting.*

JAUCH AND WOHL. *The Computer — An Accounting Tool.*

KAUFMAN. *Electronic Data Processing and Auditing.*

LAZZARO. *Systems and Procedures.*

WILKINSON. *Accounting with the Computer: A Practice Case.*

COMMUNICATION SKILLS I

Hours Per Week

Class, 3

Description

This is the first of two courses designed to enable the students to communicate effectively in their occupations. It is designed to give the student work-related learning activities that point to behavioral objectives implicit in each unit of instruction. Throughout the course, emphasis is on the practical aspects of communication with considerable attention being given to basic communication structures.

Major Divisions

		Class Hours
I.	Overview of Course and Explanation of Its Place in the Curriculum	1
II.	Fundamental Communication Structures	9
III.	Larger Communication Structures	30
IV.	Analytical Procedures of Communication	8
	Total	48

I. Overview of Course and Explanation of Its Place in the Curriculum

II. Fundamental Communication Structures
- A. Words
  1. Diction
  2. Vocabulary
  3. Idiom
  4. Usage
  5. Use of dictionaries
  6. Use of glossaries
  7. Use of handbooks
- B. Syntax
  1. Elements of the sentence
     a. Subject
     b. Predicate
     c. Expansions
  2. Sentence patterns
  3. The non-sentence
  4. Agreement of subject and verb
  5. Pronoun reference
  6. Pronoun case
  7. Clauses
  8. Phrases
  9. Mechanics
     a. Terminal punctuation
     b. Internal punctuation
     c. Syllabication
     d. Spelling
- C. Applications

III. Larger Communication Structures
- A. The expository paragraph
  1. Paragraph developed through carefully selected details
  2. Paragraph developed through use of examples
  3. Paragraph developed through extended definition
  4. Paragraph developed through classification
  5. Paragraph developed through comparison or contrast
  6. Paragraph developed through cause and effect relationship
  7. Paragraph developed through process analysis
- B. Paragraph length, content, and coherence
- C. The outline
  1. The scratch outline
  2. The topic outline
  3. The sentence outline
  4. Revising the outline
- D. Written reports on procedures, systems, meetings, lectures, and demonstrations
  1. Letter of transmittal (optional)
  2. Title page
  3. Abstract (optional)
  4. Table of contents
  5. List of tables, charts, and illustrations (optional)
  6. Explanation of symbols
  7. Report proper: introduction, body, conclusion
  8. Appendix (optional)
  9. Bibliography (optional)
  10. Index (optional)

IV. Analytical Procedures of Communication
- A. Deduction
  1. Proposition, defined
     a. Subject

b. Predicate
c. Copula
d. Quantifier

2. Deductive argument (categorical syllogism)
a. Major premise
b. Minor premise
c. Conclusion
d. Middle term
e. Distribution of middle term
f. Other rules of validity

5. Induction
1. Probability
2. Generalization
3. Analogy
4. Criteria for evaluation

C. Verification of data
D. Non-normal fallacies
1. *Ad populum*
2. *Ad hominem*
3. "Poisoning the well"
4. Appeal to force
5. Argument from ignorance
6. Fallacies of ambiguity
E. Rules for formulating definitio
F. Applications

Texts and References

HODGES. *Harbrace College Handbook.*
WARD. *Practical Technical Writing.*

COMMUNICATIONS SKILLS II

Hours Per Week

Class, 3

Description

This course is the second of two that are designed to enable students to communicate effectively in their occupations. In this course, the student deals with more specific problems of communication. The course is predicated upon the premise that communication involves the individual either as the sender or the receiver, or both, of data. Consequently, it is structured to emphasize techniques of improving the individual's role as a sender and receiver of data.

Major Divisions

		Class Hours
I.	Overview of Course and Explanation of Its Place in the Curriculum	1
II.	Aspects of Communication	2
III.	Principles of Organizing Data	5
IV.	Transmitting Data	5
V.	Receiving Data	20
VI.	The Media of Communication	15
	Total	48

I. Overview of Course and Explanation of Its Place in the Curriculum

II. Aspects of Communication
- A. Sending information (data)
- B. Receiving data
- C. Applications

III. Principles of Organizing Data
- A. Sequential
- B. Spatial
- C. Classification — division
- D. Other
- E. Applications

IV. Transmitting Data
- A. Oral
- B. Written
- C. Analyzing data for transmission
  1. What is the purpose of transmitting the data?
  2. Who will receive it?
  3. How will it be used?
  4. When is it wanted?
  5. What decisions will be based on it?
  6. What does the reader need to be told to understand the data?
- D. Applications

V. Receiving data
- A. Oral
- B. Written
- C. Analyzing data through improved reading and listening skills
  1. Overcoming faulty reading habits of subvocalization and regression
  2. Eye movements and reading patterns
  3. Speed and comprehension
  4. Developing flexible reading rates
  5. Reading and listening for main ideas and subordinate ideas
  6. Evaluating details
  7. Locating topic sentences
  8. Locating key words
  9. Detecting the speaker/writer's tone and mood
  10. Reading charts and graphs
- D. Applications

VI. The Media of Communication
- A. Oral reports on procedures, systems, meetings, lectures, and demonstrations
  1. Individual reports
  2. Group reports
  3. Preparing oral reports
     a. The audience
     b. Sources
     c. Introduction of report
     d. Body of report
     e. Conclusion of report
- B. Written reports on procedures, systems, meetings, lectures, and demonstrations
  1. Individual reports
  2. Group reports
- C. Comparison of written and oral reports
- D. Use of audio-visual materials
  1. Closed circuit television — perapara-tion of video casettes
  2. Audio tapes — cassettes
  3. Graphic aids
- E. Business letters and promotional materials
- F. Applications

Texts and References

BROWN. *Efficient Reading.*

ZELCO. *Business and Professional Speech Communication.*

SOCIETY AND WORKING RELATIONSHIPS

Hours Per Week

Class, 3

Description

The purpose of the course is to show how the findings of contemporary psychology, and of allied biological and social sciences, can provide better self understanding and understanding of others; also, how these findings can be applied to develop personal resources for effective living in today's world. Inquiry is made into the basic nature and potentialities of the individual and into associated intellectual, emotional, and social development. Attention is given to self perception in relation to environment, to motivation, personal problem recognition and solution, and to the nature of interpersonal and individual-group relationships. Although emphasis is on identifying underlying principles of human development and adjustment, consideration is given also to the implications of these principles toward effective personal behavior.

Major Divisions

		Class Hours
I.	Study of Human Behavior	6
II.	Development of Behavior	9
III.	Dynamics of Adjustive Behavior	9
IV.	Problems in Group Living	12
V.	Effective Adjustment and Personal Growth	12
	Total	48

I. Study of Human Behavior
- A. The study of human behavior
  1. Methods of evaluating knowledge
  2. Presentation of goal-directed behavior
- B. The problems of man's basic nature
  1. Good or evil
  2. Rational or irrational
  3. Free or determined
- C. Psychological "models" of man
  1. Psychoanalytic man
  2. Behavioristic man
  3. Humanistic man
  4. Existential man
- D. Man as a living system
  1. General properties of living systems
  2. Special characteristics of the human system
  3. Changes in the system with time

II. Development of Behavior
- A. Determinants of development
  1. The person
  2. Heredity
  3. Environment
  4. Self as a determinant
- B. Patterning of development
  1. Direction of development
  2. Sequence of development
  3. Highlights in development
- C. Healthy and faulty development
  1. Variations in development
  2. Early conditions conducive to faulty development
  3. Early conditions fostering healthy development
- D. Early detection and correction of defects

III. Dynamics of Adjustive Behavior
- A. Types and sources of stress
  1. Frustration
  2. Conflict
  3. Pressure
- B. Severity of stress
  1. Characteristics of the adjustive demand
  2. Characteristics of the individual
  3. External resources and supports
- C. Other key aspects of stress
  1. Stress patterns are unique and changing
  2. Stress patterns may be unconscious
  3. Key stresses in a person's life
  4. Adaptation to stress is expensive
- D. Reactions to adjustive demand
  1. The adjustment mechanisms
  2. Recognition of adjustment mechanisms

IV. Problems in Group Living
- A. Achievement of goals
  1. Respect
  2. Wealth
  3. Power
  4. Skill
- B. Career choice: an opportunity and problem
  1. Changing views of work
  2. Factors in career planning
  3. Educational preparation
- C Problems in occupational adjustment
  1. Transition from school to work

2. Meshing of individual and job
3. Special problems in vocational adjustment

D. The future world of work
1. Computers and occupational trends
2. Meshing of educational and occupational trends
3. The futurists: looking ahead

E. Goal attainment in our society
1. Achievement goals
2. Institutions and goal accessibility

V. Effective Adjustment and Personal Growth

A. Interpersonal relationships
1. Types of relationships
2. Foundations of good interpersonal relationships
3. Improving social competence
4. Helping human relationships

B. The quest for values
1. Assumptions about value
2. Values and becoming
3. Values and the future of man

C. Achievement of well-being
1. Level I
2. Level II

Texts and References

COLEMAN. *Psychology and Effective Behavior.*

ERB AND HOOKER. *Psychology of the Emerging Self.*

GNAGEY. *Student's Guide for Psychology and Effective Behavior.*

LABORATORY EQUIPMENT AND FACILITIES

Student access to appropriate equipment is absolutely essential for achieving the curriculum objectives of a post-secondary data processing education. System configurations which will meet the minimum requirements for such a program can vary greatly according to the size and type of the program to be offered. The following three approaches to providing laboratory experience are representative of current practice and illustrate the broad range of alternatives for resource allocations at most institutions. These approaches, listed by cost in ascending order, are:

1. Transport students to a computer facility located within reasonable distance.
2. Install on-campus remote terminal units connected with a central computer facility.
3. Develop a complete on-campus data processing laboratory facility.

Selection of the approach to be used in providing essential equipment for student use involves the development and consideration of critical decisions. They are critical in the sense that error can result in catastrophic financial loss in the form of an equipment array unsuited to the educational requirements. For this reason, decisions in this area should be formulated and implemented only after an exhaustive study of all relevant data available from competent, reliable sources. Resources include educational consultants, employers of data processing personnel, faculty members, and representatives of equipment manufacturers. It is of particular import that the contributions from all resources be coordinated and evaluated in conjunction with the program advisory committee. The technical knowledge, capabilities, and experience of committee members should be sought and applied most particularly in this aspect of their association with the program. Only by an enlightened marshalling of all these resources can the school be assured of obtaining the right facilities at the right cost.

Transporting Students to Computer Facilities

Colleges have used the computers at other educational institutions, governmental agencies, or commercial organizations by physically transporting the data and/or users to and from the computer site. This type of service should be considered only as a temporary or special purpose expedient. A permanent program, dependent even in part on a system of this kind, should not be initiated until a more effective mode of operation can be made available. The following discussion focuses, therefore, on the two alternatives for establishing data processing laboratory facilities in close proximity to the classroom.

Terminals Only

The basic requirement for a terminal installation is that it provide access to a time-sharing system capable of supporting whatever language is being taught. To support advanced language courses, the central system must also be able to handle current versions of the compiler.

There are two basic types of terminals having minimal space requirements, no special power demands, and requiring no structural modifications prior to installation: the CRT unit and the teletype. Input to the central computer is accomplished from both units through a keyboard. Output by the CRT unit is registered as a CRT display; by the teletype, as a hard copy printout.

Other types of terminals, classified generally as "remote batch" terminals, require special consideration because of their space, power, and communications hardware requirements. They may or may not have minimal "stand alone" capabilities. Despite these features, remote batch terminals may be entirely satisfactory for use in an on-campus facility and should be considered with this purpose in mind.

It is suggested that terminals be installed in a computer room separated from interference by concurrent classes in the other rooms. In addition to a terminal room and classroom space, facilities should include a programming workroom with storage lockers for the use of programming students. The workroom should also contain large programming tables which measure at least 4 by 5 feet and can accommodate two students simultaneously.

Fifteen to 20 full-time data processing majors are the optimal number of students served by one terminal. Intensive scheduling over each 24-hour period, however, can accommodate more students per terminal and thus reduce the total number of

units installed. Enrollment in introductory courses should not exceed more than 50 students per class section, unless there are several good laboratory instructors assigned to the class. Students can then be divided into groups of 20-25 with the laboratory instructors readily available to answer questions and provide assistance.

The major instructional limitation on a terminal installation is that a course in computer operations cannot be offered; the nature of such a course necessitates extensive "hands-on" experience for the students not available without a computer facility on the campus. In addition, a particular time-sharing system may be subject to overload, thus reducing the efficiency of instruction.

On-Campus Computer Facilities

If the use of terminals is deemed unacceptable either because of the instructional or enrollment limitations which it imposes on the curriculum, a computer facility can be installed on the campus. The amount and level of sophistication of the equipment selected naturally will be closely related to the depth and scope of the courses to be offered and the number of students to be served. If students are expected to master several programming languages, for example, the facility must have the capability of processing such input.

With the establishment of any computer facility, careful attention must be given to pre-installation planning.[6]

Building Requirements

Once the decision has been made to install a computer laboratory facility, a complete list of components to be used in the system should be prepared. This list will include the data processing equipment, furniture, tape storage cabinets, worktables, chairs, and desks. At the same time, a suitable location for the laboratory area must be chosen. Modification of existing space may provide a suitable location, or a complete new building may be necessary. The following are important considerations in selecting a location for the computer installation:

1. Availability and location of proper and adequate power (including standby power)
2. Space to house air conditioning equipment
3. Ceiling height, outside wall and glass area, factors related to the ease of air conditioning and maintaining the required humidity in the computer facility
4. Traffic flow to and from other areas
5. Floor loading capacity
6. Adequate safety and fire prevention procedures

Space and Layout

Space and layout requirements hinge on the physical area available and the dimensions of the specific components to be installed. Floor area will be determined by the length-to-width ratio of the room, location of columns, provisions for future expansion, and other such factors. The exact area required for a specific group of components can be determined from a machine layout made by using the measurements of the room under consideration.

Space should be provided for the daily storage of tape, cards, and printed forms within the computer room. All other combustible materials such as permanent master documents, punched card records, and magnetic tape should be stored in properly designed and protected storage areas. Storage areas are best located so that both the amount of space required and the travel time between areas is minimized. Space must be planned also for storage cabinets, card and record files, printer forms, worktables, desks, and communications facilities.

In addition, the equipment manufacturer may assign test equipment to the installation to maintain the equipment in the machine room; space will need to be allocated for this purpose. Some machines may be moved to the test area, depending on the type of work to be done. Whenever possible, test areas should be on the same floor level; if they are not, ramps must be provided for moving test equipment and machine components. Detailed space requirements and specifications for the test area can be obtained by consulting with the system manufacturer's field engineers.

Floor Construction

A structural engineer should be consulted to determine whether the floor of the proposed facil-

[6]Detailed information on computer installation planning and implementation usually is available on request from hardware manufacturers.

ity is capable of supporting the system weight load. A raised or false floor can be constructed of steel, aluminum, or fire-resistant wood and will accomplish the following major objectives for building design:

1. Allow for future layout change with minimum reconstruction cost.
2. Protect the interconnecting cables and power receptacles.
3. Provide for personnel safety.
4. Permit the space between the two floors to be used to supply air for the air conditioning system.

The two general floor types are illustrated in figure 7. The free-access floor panel lifter should be made readily available at a convenient location in the computer room.

Floor covering material can contribute to the building of high static electrical charges resulting from the movement of people and equipment in contact with the floor material. The abrupt discharge of this static electricity can cause discomfort to personnel and may result in the malfunction of electronic equipment. The build-up and discharge of static electricity can be minimized by providing a conductive path to ground from a metallic raised floor structure, and ensuring that maximum resistance for floor tile or other floor surface material is 2×10^{10} ohms, measured between floor surface and building.[7] Carpet floor covering should be of the "antistatic" type, either having antistatic properties manufactured into the material or designed to be treated with antistatic agents.

Vacuuming equipment used in the machine area should have a non-conductive hose and nozzle assembly. This safety precaution minimizes the possibility of static discharge or electrical shock.

Acoustics and Lighting

The principal sources of noise in a computer facility are the mechanical units such as card punch machines, printers, readers, sorters, and blowers. The walls and the floor should be constructed to prevent the transmission of noise and vibration to adjacent areas. Walls and doors must be solidly constructed and have a good seal. The greatest sound reduction will be obtained by installing a dropped porous ceiling. Precautions must also be taken to prevent the transmission of noise generated in the machine room through overhead ducts to other rooms. Floor and the wall surfaces should likewise be covered with absorptive materials to prevent reverberations.

The machine room area should be lighted with a minimum average illumination of 40 footcandles, measured 30 inches above the floor. Direct sunlight should be avoided because various console and signal lamps can be best observed under lower levels of illumination. Direct sunlight may also cause devices that employ light sensing (such as certain magnetic tape units) to malfunction. Lights for general illumination should be sectionally controlled by switches so that a portion of the lighting can be turned off as desired. Lights should not be powered from the computer power panel.

Air-Conditioning

Computer components are internally cooled by air circulated by blowers within the unit. Air intake is generally through the bottom and also through louvers along the bottom edge. Warm air usually exhausts from the top of each unit.

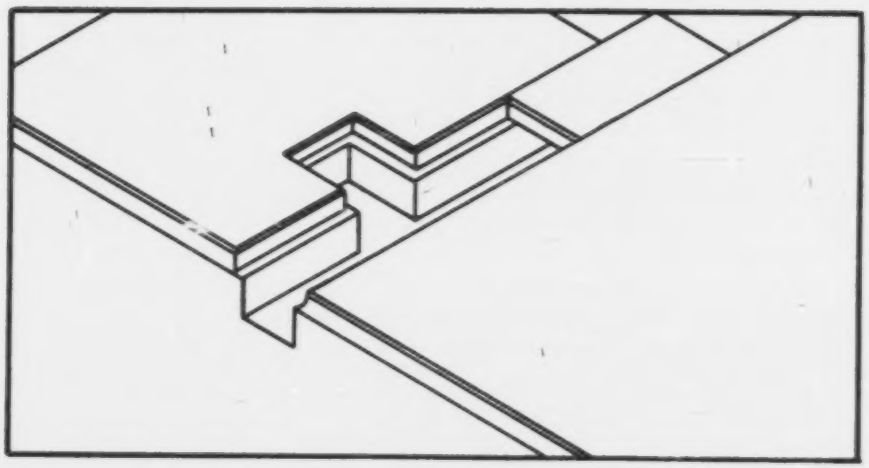
The following factors must be considered in determining the air-conditioning capacity necessary for an installation:

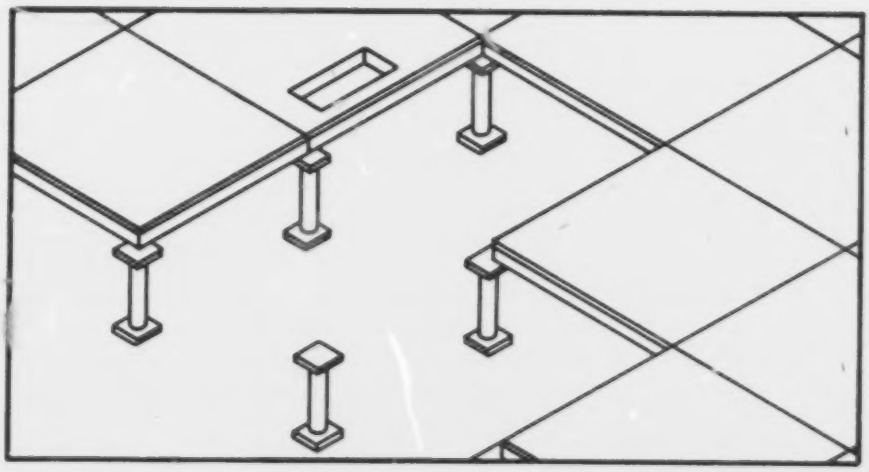
1. Machine heat dissipation
2. Personnel
3. Latent load
4. Fresh air introduction
5. Infiltration of heat through outer walls
6. Ceiling
7. Floors
8. Door openings
9. Partitions
10. Glass wall areas
11. Possible reheat

A separate air-conditioning system is recommended for a data processing installation; it is necessary for the system to maintain a cooling cycle year-around. The air-conditioning should be designed to operate at 75 degrees Fahrenheit and 50 percent relative humidity at altitudes up to

[7]The procedure outlined in the *National Fire Protection Association Standard No. 56*, chapter 25, section 2522, should be used.

Raceway floor:
Removable covers
with cutouts





Free access floor:
Pedestal supported,
removable panels with
cutouts

Free access floor:
Subframe supported,
removable panels
with cutouts

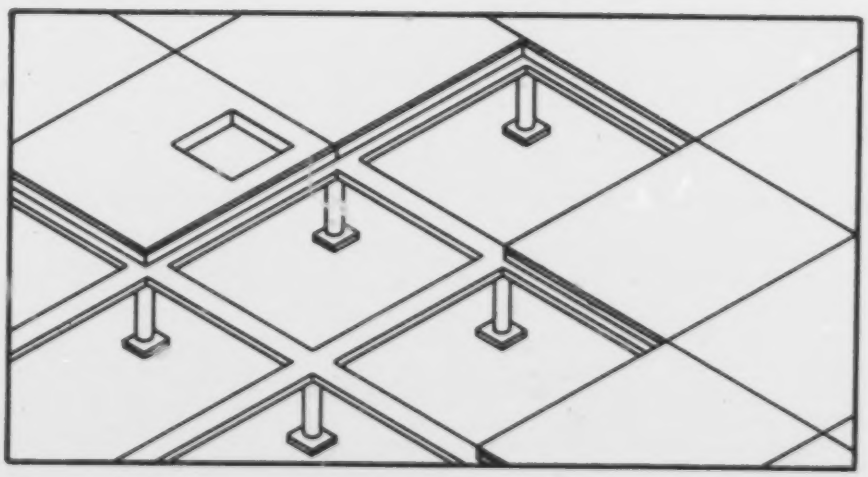


Figure 7. — Types of raised flooring

7,000 feet. This provides the largest buffer of available system time in the event that the air-conditioning system fails or malfunctions. The computer will be able to operate until it reaches its specified limits and the possibility is increased that repairs can be effected before the computer must be shut down. This standard has a generally acceptable level of personal comfort.

The heat load of the computer system is concentrated in a relatively small area. For this reason, air distribution should be designed to eliminate areas of excess air motion.

The air-conditioning system should use predominantly recirculated air with a set minimum for introduction of fresh air for personnel. This minimum fresh air introduction will enable the machine area to be pressurized so that air leakage is always outward, thus minimizing dust entry from adjacent areas.

Several types of air-conditioning systems can be designed to satisfy the temperature and humidity requirements, including:

1. Single duct (overhead system)
2. Two duct (two air-conditioning unit system)
3. Two duct (single air-conditioning unit system)
4. Underfloor system.

It is recommended that an experienced air-conditioning design engineer consider each of the methods of air distribution and check all local building codes. The electrical code should also be verified, since some localities will not permit the use of the raised floor for air-conditioning.

Safety and Fire Precautions

Safety considerations are an important factor influencing the choice of computer location, building materials, an air-conditioning and electrical system, and fire prevention equipment.[8]

The computer should be in a non-combustible or fire-resistent building or room and should not be adjacent to areas where inflammable or explosive materials or gases are located. Walls should be of non-combustible materials and should extend from the floor to the ceiling.

If a computer area has one or more outside walls adjacent to a building that is susceptible to fire:

1. Installation of shatterproof windows in the computer room would improve the safety of personnel and equipment from flying debris and water damage.
2. Sprinklers could be installed externally over the windows to protect them with a blanket of water in case of fire in the adjacent area.
3. Windows could be sealed with masonry.

Where a hung ceiling and raised floor are used, they should be constructed of non-combustible material; all ducts and insulating should likewise be fire-resistant and nondusting. The roof or floor above the computer and tape storage areas should be a watertight slab. If possible, the walls of the room should be sealed to the slab in a way to prevent water from entering overhead.

Any data stored in the computer room, whether in the form of magnetic tape, paper tape, cards, or paper forms, should be limited to the minimum needed for safe, efficient operation and should be enclosed in metal cabinets or fire-resistant containers.

After having consulted with the appropriate architectural and electrical engineers and the representatives of various equipment manufacturers on pre-installation planning considerations, an institution is ready to design and equip an actual computer facility. The amount and level of sophistication of the equipment to be selected will hinge primarily on the goals of the program and the number of students and staff members to be involved in its operation. It is recommended that an institution initiating a data processing curriculum might do so in phases, both because of budgetary considerations and because of the need to proceed with studied deliberation in a new curriculum area. A gradual, planned development of a total capability in the data processing field is the preferable and more realistic course for most institutions.

The laboratory facilities discussed in following paragraphs are suggested as ample to meet the requirements of a typical 2-year program involving 30-35 beginning students, 20 advanced students, and four instructors in the technical specialty courses. Students in excess of this number can be accommodated by providing multiple laboratory sections.

[8]For additional reference material, consult NFPA Standard No. 75, "Protection of Electronic Computer/Data Processing Equipment."

Figures 8 and 9 represent examples of floor plans. It must be recognized that the development of data processing facilities is highly dependent upon the types and quantities of equipment selected. In many cases, the location of specific equipment will limit the locating of other equipment. For example, the selection of a location for the central processing unit dictates, to a large extent, the location of input-output devices, tape units, secondary storage units, and other devices which are physically connected to the CPU. Doorways should be located for easy traffic flow into and out of the laboratory. In addition, storage areas in laboratories should be located so that the instructor can readily control the security of key programs and software. Consideration must also be given to the storage of diagnostic programs and maintenance equipment belonging to equipment vendors. Again, the amount of space required is dependent upon the equipment selected and should be determined during the period of equipment negotiations with the vendor.

The sample layout includes a student programming room consisting of individual programming carrels. The advantage of this arrangement is evident when one considers the degree of concentration required for program writing and the characteristics of individualism and creativity which enter into each meaningful program. In addition, a keypunch machine is kept in this room to insure that students can punch data without intruding on a class in the regular keypunch room.

Office and Classroom Space

Suggested office space for staff members is indicated in the diagrams of a data processing facility. Private office space should be provided for each instructor; more than one staff member occupying an office tends to discourage students from approaching an instructor for assistance. If space permits, it is desirable to have a waiting room adjacent to staff offices where students can study comfortably while waiting for the instructor's assistance. The waiting room can be the responsibility of the departmental secretary, who often is assigned the duty of arranging conference appointments for students.

Classroom space can be of any size, but if an institution is involved with constructing a new facility, care should be taken to insure a variety of room sizes to accommodate both large introductory sections and smaller instructional groups. The room devoted to keypunch instruction should be large enough to accommodate an average size class and should be soundproofed sufficiently to avoid disturbing other classes or personnel in the immediate vicinity. An office within the classroom would be desirable for student-teacher conferences related to ongoing class work or a quiet place for the instructor to monitor class exercises and examinations.

Equipment Costs

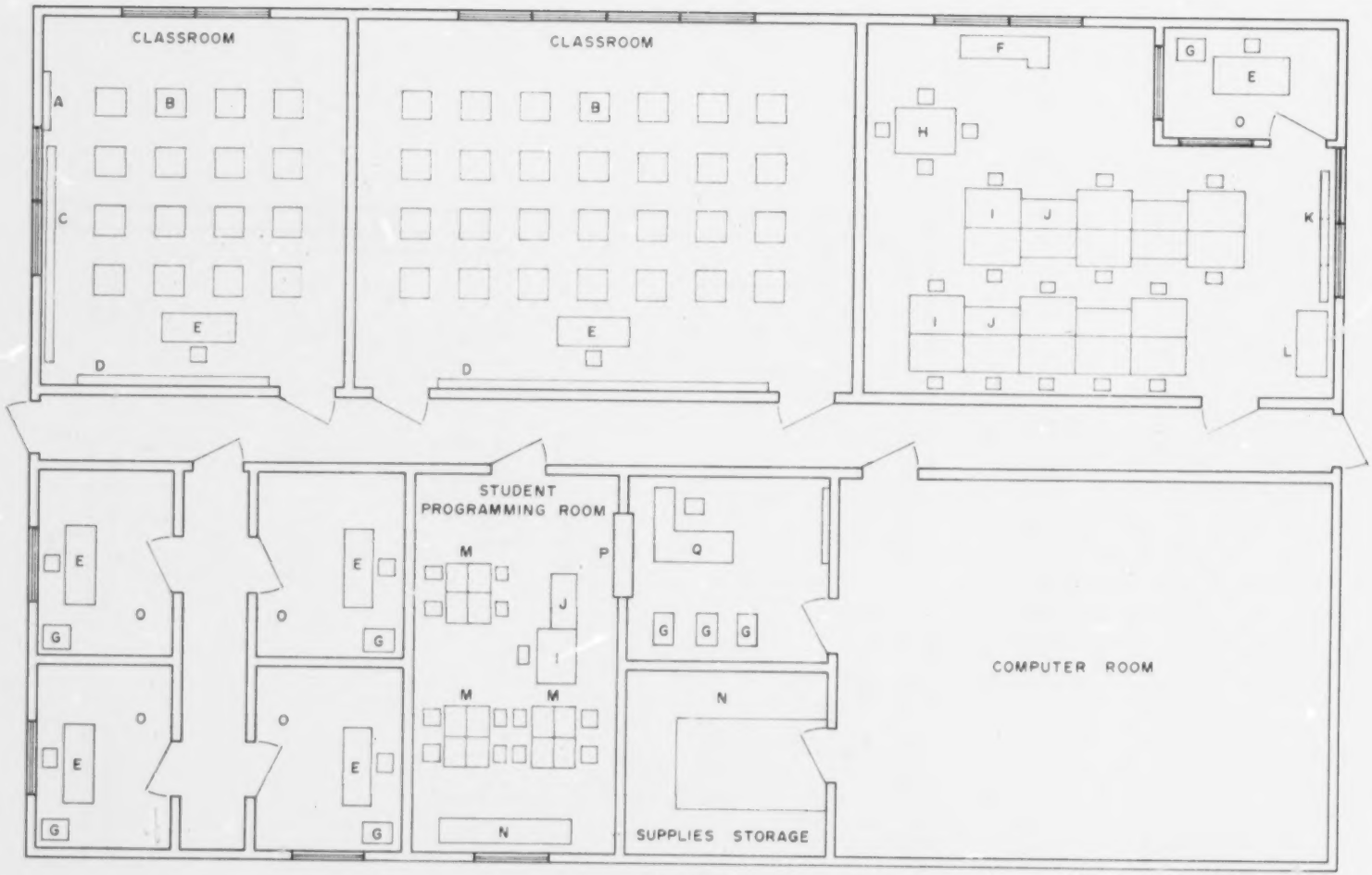
The cost of equipment[9] is a prime consideration when planning a data processing education program. Equipment can be rented or leased, or new or used equipment can be purchased. Reaching a decision on which course to follow is complicated by the availability of options with each piece of equipment and the necessity for a maintenance contract. In addition, equipment vendors have developed a policy of offering an education discount ranging from 10 to 60 percent. Whether equipment is purchased or leased, a monthly maintenance fee is a major budgetary item. Varying in amount with specific equipment and options, the figure must be negotiated with prospective vendors.

Approximate costs of computer equipment are listed in tables 3 and 4. The figures stated represent the cost of the equipment installed by the vendor, but they do not include the cost of the building, special flooring, air conditioning, or other such items. However, the amounts listed can be considered as generally typical of the level of funds necessary to obtain various items of equipment for an educational data processing center.

The largest single item of cost is for the central processing unit (CPU). Educational institutions, planning a computer facility for instructional purposes only, seldom will find it necessary to obtain a CPU larger than medium size. The exception to this generality can occur if local businesses, industrial concerns, government agencies, or other schools arrange to share, and thus pay for, the added productive capacity of a large unit.

The mini or small computer probably is most widely used in school computer facilities. By their

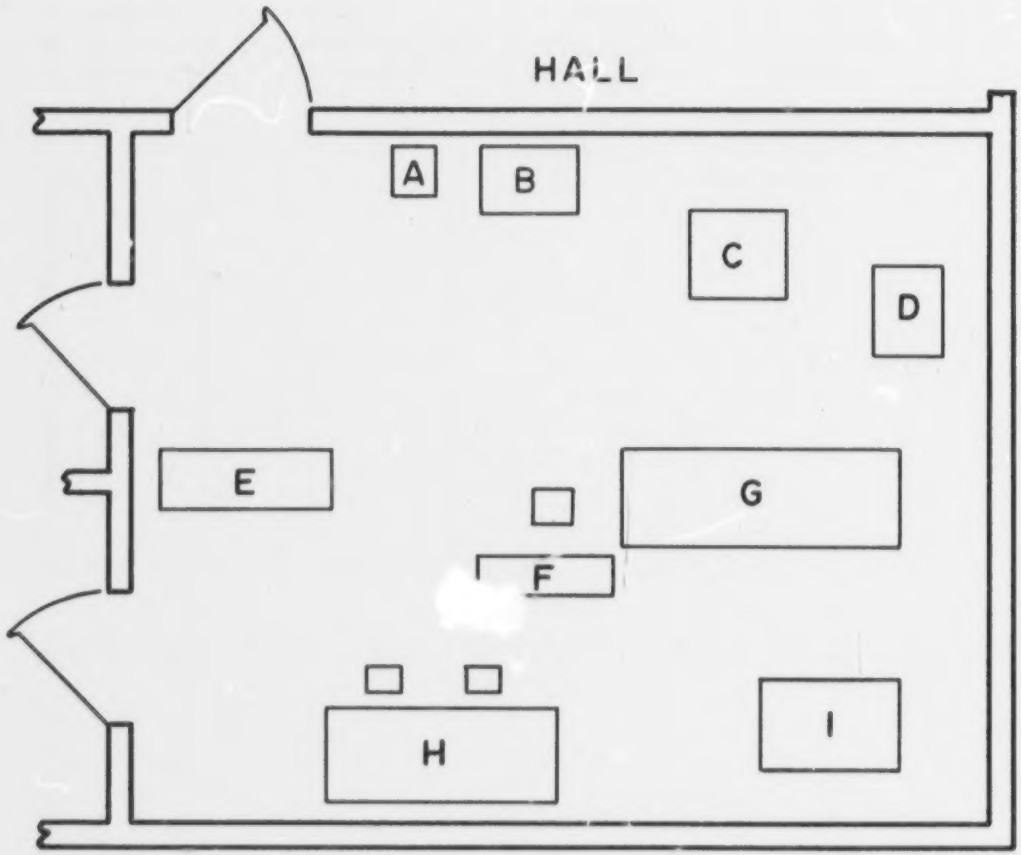
[9] *BUSINESS AUTOMATION*, vol. 18, no. 14: Hitchcock Publishing Co., Wheaton, Ill. Dec. 1971.



LEGEND

A. Bulletin Board	D. Chalk Board	G. File Cabinet	J. Verifier	M. Programming Carrels	P. Window Counter
B. Student Desk	E. Instructor's Desk	H. Work Table	K. Card Racks	N. Storage Shelves	Q. Manager's Desk
C. Bookcase	F. Sorter	I. Keypunch	L. Interpreter	O. Instructor's Office	

Figure 8. — Computer center layout



LEGEND

A. Card file
B. Keypunch
C. Magnetic tape unit
D. Disk storage
E. Card I/O unit
F. I/O terminal
G. Central processing unit
H. Programming table
I. Printer

Figure 9. — Computer room layout

Table 3. — Estimated Purchase Costs and Monthly Rental on Computer Equipment[10]

Description	Purchase Costs	Rental Per Month
Central Processing Unit	$75,000 to $120,000	$1,400 to $2,000
Card I/O unit	25,000 to 35,000	500 to 600
Secondary storage units (2)	35,000 to 45,000	1,000 to 1,500
Printer	25,000 to 35,000	300 to 450
Keypunch machines (each)	1,000 to 1,200	60 to 75
Sorter	2,500 to 3,000	40 to 50
Card verifier	2,500 to 3,000	40 to 50
Interpreter	5,000 to 6,000	100 to 150
Card files	50 to 75	
Sorting rack	50 to 75	

Table 4. — Computer System Classification by Size and Cost[11]

Computer Size	Monthly Rental
Mini	under $1,200
Small	$ 1,200 to $ 5,000
Medium	5,000 to 40,000
Large	30,000 to 150,000

[10]John W. Hamblen, "Central Computer Center Organization and Computer Systems Options for Institutions of Higher Education," prepared for *Proceedings of Conference on Computers in Instruction: Their Future in Higher Education*, RAND Corporation, Oct. 1-3, 1970).

[11]The cost of equipment is directly related to the size and capability of the configuration desired by the institution and to the manufacturer selected.

use, smaller institutions are provided with computing capability with "their own" computer. The total annual operating costs for systems in these classes range from $10,000 to $60,000. The hardware varies from an 8-kilobit system with teletype input/output plus one symbolic and one compiler language upwards to a 16-kilobit unit with disk or tape, card reader and punch, line printer, and multiple language capability. The smaller of these systems are of the "batch" type while the larger systems are capable of time-sharing operations.

All the foregoing factors should be considered in detailed cooperation with the advisory committee to formulate decisions that specify the course of action to implement, the equipment to select, the price to pay, and the vendors with whom to negotiate.

Supplies

When compiling a budget for computer center operations, the cost of supplies is a significant factor. In addition to supplies usually required for office and classroom use, several items must be procured that are unique to computer operations. These include data punch cards, single- and multiple-form printer paper, and magnetic tape. Procurement should be organized to ensure that supplies always are available in sufficient volume to support ongoing and projected data processing operations.

Non-Instructional Support

Most computer centers associated with data processing educational programs will be involved also in supporting other institutional functions such as payroll preparation, other business office operations, and student registration and class assignment. Budgeting and accounting related to these activities should be isolated from corresponding data relating to the instructional program.

Since a computer center, equipped and staffed to perform instructional and non-instructional support functions, represents a large, complex operation, the services of a full-time, technically qualified director usually are required.

LIBRARY SUPPORT

The evolution of libraries from the traditional print-oriented centers into centers providing all types of resources and services to meet instructional and individual needs has been accelerated in the past decade. This organization of various print and nonprint materials into a single administrative unit to provide the resources, regardless of format, has been incorporated into this guide. There is no expectation that every institution should be forced into this single immutable mold. These recommendations are designed to aid the institutions in the implementation of their educational goals and strengthening of their instructional programs. In some institutions these goals and objectives will require alternative approaches.

In the evaluation of any technology preparation program, a tangible indication of the strength of the program is provided in the qualifications of the librarian and staff, the organization of the physical facilities, and the quality, quantity, and pertinence of materials.

Instruction for students in data processing should be in part library-oriented, to equip the student with the proper skills to readily locate information related to any courses under study. Since the library center can be an invaluable tool in the learning process, this knowledge can help to develop a professional attitude in students and to further encourage them to regard libraries as a source for future updating on new developments in the field of data processing.

Instructors of all courses should constantly keep the student aware of the extent to which a library contains useful information helpful in the study of any course within the curriculum. This can be achieved by assigning library projects, open-book examinations requiring the use of reference sources, or in other less direct ways.

The professional growth and success of data processing graduates will depend largely upon their ability to keep abreast of changes in this field. Libraries are information source agencies with trained personnel who classify source data and assist those seeking it to find pertinent information quickly.

Because of its direct relationship to the institutional objectives the role of the library learning resource center is threefold: to provide an organized and readily accessible collection of print and nonprint materials needed to meet institutional, instructional, and individual needs of students and faculty; to provide a staff qualified, concerned, and involved in serving the needs of students, faculty, and community; and to encourage innovation, learning, and community service by providing facilities and resources which will make these possible.

Library Staff and Budget

The head librarian usually reports to the top administrative officer of the school and has full faculty status. American Library Association standards suggest that "two professional librarians are the minimum number required for effective service in any junior college with an enrollment up to 500 students (full time equivalent). In addition, there should be at least one nonprofessional staff member. The larger the institution, the more appropriate it will be to employ a higher proportion of nonprofessional staff members. Great care should be taken that professional staff members do not spend their time doing work that is essentially clerical, because this is not only wasted but also demoralizing."[12]

Professional staff members provide faculty and students with a wide variety of services, including instruction in the use of the center and its resources to individual students or in the classroom. They help students to gain skills in the techniques of research and evaluation and encourage the development of desirable listening, viewing, and reading patterns. Library staff members also serve as materials specialists and consultants to the faculty, evaluating and selecting materials for the center; they make materials accessible to students and faculty through the cataloging and classification system and produce and assist faculty to produce materials for instructional use to supplement those available through other sources. In addition, the library staff supervises the work of the center.

According to the American Library Association, the library budget should be determined in relation to the total budget for educational and general expenditures of the institution; however, the amount to be allocated to the library should also

[12]Association of College and Research Libraries, *ALA Standards for Junior College Libraries*, Chicago, Ill.: ACRL, 1960, p. 3.

be based upon a program of optimal library service supportive of the school's objectives. The execution of the library program outlined in the American Library Association standards normally requires a minimum of five percent of the total educational and general budget. This minimum percentage is for a well-established library with an adequate collection. It would have to be augmented if there should be a rapid increase in the student body or in course offerings; it would again need to be increased if the library should be made responsible for an audio-visual program. The library budget for a newly organized institution should naturally be considerably larger than five percent.

Another criterion for the library budget, approved by the American Library Association, is that the funds for acquiring new library materials at an established library should equal or exceed the cost of the total library staff; the expenditure for acquisition of new library materials should be substantially greater when libraries are just starting or when major additions of curricula are being made.

The basic budget is related to many factors, including the purposes and functions of the institution, adequate prior provision of a basic collection of print and nonprint materials, growth rate of the institution, curriculum change or growth, type of service rendered; also, to the size of the faculty, size and kind of student body, center staff, physical facilities in which the center operates, availability of other learning resources to faculty and students, and the extent to which commercial processing centers are utilized.

Library Content

Library resources and content must adequately review the literature devoted to all the subjects in each curriculum and extend somewhat beyond the degree of instructional complexity encountered by students in classroom activities. It should also have sufficient resources to meet the needs of the faculty as they continue to update their professional knowledge of recent developments in their respective fields.

In this regard, library resources may be classified as basic encyclopedic and reference index material, reference books pertinent to the data processing technology, periodicals and journals, and visual aids.

The faculty and the library staff should cooperate in determining what materials are to be acquired and should be responsible for the final selection of the materials that support their courses. They must take the initiative in recommending materials to keep the library current, pertinent, and useful. The library staff should supply instructors with periodic lists of recent acquisitions complete with call numbers. Technical and trade journals should either be circulated among the teaching staff or placed in a staff reserve section for a brief time before they are made available for general library use.

In addition to reference materials, journals, and trade publications, a library should have encyclopedias available for ready reference and should maintain index material such as the *Applied Science and Technology Index* to aid staff and students in finding recent material on specific subjects.

It is recommended that microfilms and visual aid materials be centered in the library. These materials should be reviewed and evaluated by both the librarian and a member of the teaching staff. This procedure will inform the teaching staff on what visual aids are available and where they may be best put to use in the technical programs.

A well-equipped, modern library-media center should have some type of duplicating services available so that copies of library materials may be easily obtained by students and staff. Such a service allows both students and staff to build up-to-date files of current articles appropriate to the courses in a program. The service should be available to the students at a minimum cost and free of personal cost to the teaching staff.

Further specific suggestions and discussion of library-media center content for the data processing program follow.[13]

Encyclopedic and Reference Index Material

This portion of the library-media center content is basic in that it contains the broadly classified and organized cataloging of all available

[13] "American Association of Junior Colleges — Association of College and Research Libraries Guidelines for Two-Year College Library Learning Resource Centers." *College and Research Libraries News*, no. 9, October 1971, pp. 265-278.

knowledge pertinent to the objectives served by the library and the programs which it supports.

The reference collection includes a wide selection of significant subject and general bibliographies, authoritative lists, periodical indexes, and standard reference works in all fields of knowledge.

Every institution requires extensive bibliographical materials for use in locating and verifying items for purchase, for borrowing through interlibrary loan, for providing for subject needs of users, and for evaluating the collection.

Technical Journals and Periodicals

The importance of this portion of the library-media center content has previously been emphasized. These publications represent the most recent and most nearly complete presentation of new knowledge and new applications of principles in any specific area of applied science. It is essential that both instructors and students make frequent and systematic use of such literature to keep their technical information current.

Careful selectivity should be exercised in retaining and binding or in microfilming these periodicals for permanent library use. Some represent important reference material which may be used for many years; however, many should not be bound for permanent reference material, because the really important material which they contain will be assimilated into a handbook or textbook to be presented in a more compact and usable manner within a year or two.

The following is a typical list of technical journals, periodicals, and trade magazines which would be desirable in the library-media center of an institution offering course work in the area of data processing.

AUTOMATION: The Penton Publishing Company, Penton Building, Cleveland, Ohio 44113

AUTOMATION AND REMOTE CONTROL: Instrument Society of America, 530 William Penn Place, Pittsburg 15219

COMMUNICATIONS OF THE ACM: Association for Computing Machinery, 211 E. 43rd St., New York 10017

COMPUTERS AND AUTOMATION: Berkeley Enterprises, Inc., 815 Washington St., Newtonville, Mass. 02160

COMPUTER CHARACTERISTICS QUARTERLY: Adams Associates Inc., 575 Technology Square, Cambridge, Mass. 02139

COMPUTER DIGEST: American Data Processing, Inc., 4th Floor, Book Building, Detroit, Mich. 48226

COMPUTER AND THE HUMANITIES (NEWSLETTER): Queens College of the City University of New York, Fushing, N.Y. 11367

COMPUTER NEWS: Technical Information Company, Martins Bank Chambers, P.O. Box 59, St. Helier Jersey, British Channel Islands.

COMPUTER JOURNAL: The British Computer Society, Finsbury Court, Finsbury Pavement, London, E.C.2.

COMPUTING REPORT FOR THE SCIENTIST AND ENGINEER: Data Processing Division, International Business Machines Corporation, White Plains, N.Y. 10601

COMPUTING REVIEWS: Association for Computing Machinery, 211 E. 43rd St., New York 10017

DATAMATION: F. D. Thompson Publication, Inc., 205 W. Wacker Dr., Chicago 60606

DATA PROCESSING DIGEST: Data Processing Digest, Inc., 1140 South Robertson Blvd., Los Angeles 90035

DATA PROCESSING FOR EDUCATION: American Data Processing Inc., 4th Floor, Book Building, Detroit 48226

DATA PROCESSING MAGAZINE: Data Processing Magazine, 134 North 13th Street, Philadelphia 19107

D.P.M.A. QUARTERLY: Data Processing Management Association, 505 Busse Highway, Park Ridge, Illinois 60068

INFORMATION RETRIEVAL LETTER: American Data Processing, Inc., 4th Floor, Book Building, Detroit 48226

JOURNAL OF MATHEMATICAL ANALYSIS AND APPLICATIONS: Academic Press, Inc., 111 Fifth Avenue, New York 10003

JOURNAL OF THE ASSOCIATION FOR COMPUTING MACHINERY: 211 E. 43rd Street, New York 10017

JOURNAL OF SYMBOLIC LOGIC: Association for Symbolic Logic, Inc., P.O. Box 6248, Providence, Rhode Island 02940

OPERATIONS RESEARCH QUARTERLY: Pergamon Press Ltd., Headington Hill Hall, Oxford, England

OPERATIONS RESEARCH: Operations Research Society of America, Mount Royal and Guilford Avenues, Baltimore 21202

SUPERVISORY MANAGEMENT: American Management Association, Inc., 135 West 50th Street, New York 10020

SYSTEMS AND PROCEDURES: Systems and Procedures Association, 7890 Brookside Drive, Cleveland 44138

The Book Collection

The American Library Association states that:

> . . . a two-year institution of up to 1,000 students (full-time equivalent) cannot discharge its mission without a carefully selected collection of at least 20,000 volumes, exclusive of duplicates and textbooks. Institutions with broad curriculum offerings will tend to have larger collections; an institution with a multiplicity of programs may need a minimum collection of two or three times the basic figure of 20,000 volumes. The book holdings should be increased as the enrollment grows and the complexity and depth of course offerings expand. Con-

sultation with many junior college librarians indicates that for most, a convenient yardstick would be the following: The bookstock should be enlarged by 5,000 volumes for every 500 students (full-time equivalent) beyond 1,000.[14]

At the initiation of a data processing program, it is suggested that the head of the program and the librarian review the current pertinent reference books available and select a list of books to be placed in the library as regular reference material. A recommended policy is to place in the library-media center only those reference books which are not a part of the regular textbook material for the various computer courses.

It is also suggested that at the beginning of a program, such as the one recommended by this curriculum guide, the library-media center should contain at least 200-300 reference books on various aspects of data processing, computer science and its related fields. Beyond the initial 200 to 300 books, there should be annual additions to the reference materials in the library-media center supporting the program, and eventually an elimination of those references which have become obsolete.

Visual Aids

The same procedure outlined previously for the acquisition of books pertinent to the data processing program is also suggested for procuring the visual aids content in the library-media center. Both the librarian and the head of the program should review and evaluate visual aids materials as they become available, and those which are deemed appropriate should be borrowed for special use or purchased for regular use.

Media equipment should be available when needed; this is best accomplished with centralized control of distribution and servicing. Thorough and continual evaluation is essential to insuring that equipment on hand or on order is sufficient for current and projected requirements.

[14]Association of College and Research Libraries, *op. cit.* p. 4.

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APPENDIXES

Appendix A

A Selected List of Film Distributors

American Telephone and Telegraph
(Write or phone local office.)

Bell Telephone Company
(Write or phone local office.)

California Computer Products
2411 W. La Palma Avenue
Anaheim, California 92801

City University of New York
Audio-Visual Center
School of Business & Public Administration
17 Lexington Avenue
New York, New York 12452

Data Processing Management Association
505 Busse Highway
Park Ridge, Illinois 60668

Detroit Public Schools
5057 Woodward Avenue
Detroit, Michigan 48202

DeVry Technical Institute
4141 Delmont Avenue
Chicago, Illinois 60641

Educational Development Center
39 Chapel Street
Newton, Massachusetts 02158

Encyclopedia Britannica, Inc.
Educational Division
425 North Michigan Avenue
Chicago, Illinois 60611

Film Associates of California
1159 Santa Monica Boulevard
Los Angeles, California 90025

Ford Motor Company
Film Library
The American Road
Dearborn, Michigan 48121

General Dynamics
Electronic Division
San Diego, California 92101

General Electric Company
FPD Technical Information Center
Cincinnati, Ohio 45215

General Electric Educational Films
60 Washington Avenue
Schenectady, New York 12305

General Motors Corporation
Film Library
Warren, Michigan 48089

Harvard University
Cambridge, Massachusetts 02138

John Wiley & Sons, Inc.
Educational Services
605 Third Avenue
New York, New York 10036

Ideas Information
P.O. Box 446
Melbourne, Florida 32901

Massachusetts Institute of Technology
Electronic Systems Laboratory
Cambridge, Massachusetts 02139

Modern Talking Picture Service, Inc.
2323 New Hyde Park Road
New Hyde Park, New York 11040

National Cash Register Company
Audio-Visual Section
Dayton, Ohio 45409

National Film Board of Canada
680 Fifth Avenue
New York, New York 10036

National Science Film Library
1762 Carling
Ottawa 13, Ontario, Canada

NET Film Service
Indiana University
Audio-Visual Center

Bloomington, Indiana 47401
Orange Coast Junior College
Costa Mesa, California 92626

Oregon State University
Division of Continuing Education
A. V. Section, Coliseum 131
Corvallis, Oregon 97331

Pennsylvania State University
Audio-Visual Services
University Park, Pennsylvania 16802

Purdue University
Audio-Visual Center
Lafayette, Indiana 47907

Radio Corporation of America
Film Library
Camden, New Jersey

Rand Corporation
1700 Main Street
Santa Monica, California 90401

Recognition Equipment Incorporated
815 Connecticut Avenue
Washington, D.C. 20015

Reelife Productions
1809 Via Visalia
Palos Verdes Estates, California 90275

Systems Development Corporation
2500 Colorado Avenue
Santa Monica, California 90404

U.S. Navy
(Write or phone the nearest U.S. Navy Base.)

Union Carbide Corporation
270 Park Avenue
New York, New York 10017

UNIVAC Film Library
UNIVAC Division
Sperry Rand Corporation
P.O. Box 8100
Philadelphia, Pennsylvania 19117

University of California
Media Center
Film Distribution
Berkeley, California 94720

University of Georgia
Film Library
Center for Continuing Education
Athens, Georgia 30601

University of Illinois
704 South Sixth Street
Champaign, Illinois 61820

University of Iowa
Audiovisual Center
Division of Extension and University Services
Iowa City, Iowa 52240

University of Michigan
Audio-Visual Education Center
416 Fourth Street
Ann Arbor, Michigan 48103

Appendix B

A Selected List of Professional Societies and Associations In The Field of Data Processing

AMERICAN FEDERATION OF INFORMATION PROCESSING SOCIETIES (AFIPS)

210 Summit Ave.,
Montvale, N. J. 07645

History

AFIPS is an outgrowth of the National Joint Computer Committee (NJCC), which was organized in 1951 for the purpose of sponsoring and coordinating the Eastern and Western Joint Computer Conferences. It was recognized that information processing had become a national concern and a need existed for a centralized information source. In recognition of this problem, members of the NJCC caused the AFIPS to be formed on May 10, 1961.

Purpose

AFIPS is a society founded to promote the advancement and dissemination of knowledge of the information processing societies. Some of the purposes of AFIPS included in its constitution are: "To promote unity and effectiveness of effort among all those who are devoting themselves to information processes by research, by application of its principles, by teaching or by study; and to foster the relations of the sciences of information processing to other sciences and to the arts and industries."

Membership

Consists of members of associated societies who are engaged in, closely related to, or interested in the information processing sciences.

Publications

Proceedings (each Joint Computer Conference)

ASSOCIATION FOR COMPUTING MACHINERY (ACM)

1133 Avenue of the Americas
New York, N.Y. 10036

History

ACN was organized in 1947 as the Eastern Association for Computing Machinery. In 1948, the word Eastern was dropped, and the organization has since been known as the Association for Computing Machinery.

Purpose

The Association for Computing Machinery is perhaps the most technically oriented of all the computer and data processing organizations. The purposes of ACM are: (1) "To advance the sciences and arts of information processing including, but not restricted to, the study, design, development, construction, and application of modern machinery, computing techniques and appropriate languages for general information processing, for scientific computation, for the recognition, storage, retrieval, and processing of data of all kinds, and for the automatic control and simulation of processes." (2) "To promote the free interchange of information about the sciences and arts of information processing both among specialists and among the public in the best scientific and professional tradition."

Membership

Any person or institution having interest in accord with the purposes of the association may obtain membership. There are three recognized classes of membership: institutional, regular member, and student member.

Publications

Journal of the Association for Computing Machinery
Communications of the ACM
Computing Reviews

ASSOCIATION FOR EDUCATIONAL DATA SYSTEMS (AEDS)

1201 16th St., N.W.
Washington, D.C. 20036

History

AEDS was formed in 1962 as a professional association for educational data processing and information management personnel.

Membership

AEDS membership consists of directors of school data processing centers, officials of state departments of education, and directors of college and university computer centers.

Publications

AEDS Bulletin
EDF Newsletter
Journal of Educational Data Processing

ASSOCIATION FOR SYSTEMS MANAGEMENT (ASM)

24587 Bagley Road
Cleveland, Ohio 44138

History

In May, 1944, a group of businessmen organized themselves in Philadelphia for study, research, and training. Several years later, the Philadelphia group merged with a similar group in Delaware. The result of this and subsequent mergers was the formation of the Systems and Procedures Association. In 1969, the name was changed to Association for Systems Management.

Purpose

To gain information and exchange ideas relative to systems and procedures. The association collects and disseminates information on system courses taught throughout the nation.

Membership

Open to those who are actively engaged in systems and procedures.

Publications

Journal of Systems Management (monthly)
International Newsletter
Ideas on Management (annual)

ASSOCIATION OF DATA PROCESSING SERVICE ORGANIZATIONS (ADAPSO)

551 5th Ave.,
New York, N.Y. 10017

History

ADAPSO was the result of a meeting in early 1960 between groups of company representatives who came together to consider the feasibility of organizing. Subsequent meetings were conducted and the result was the formation of the ADAPSO on June 8, 1960. The first headquarters office was established in January, 1963.

Purpose

ADAPSO serves member companies through an inquiry service, legislative activity, simplified accounting, salary surveys, the development of ethical standards, the determination of liability, and by enhancing a better understanding with the professions, especially accounting, law, engineering, banking, and management consulting

Membership

Consists of service center organizations concerned with serving clients through data processing for a profit.

Publications

ADAPSO News
ADAPSO Proceedings
Directory of Data Processing Service Organizations
Computer Services Journal (bimonthly)
Industry Survey of Computer Services Industry (annual)

BUSINESS EQUIPMENT MANUFACTURERS ASSOCIATION (BEMA)

1828 L St., N.W.
Washington, D.C. 20036

History

Organized in 1916 as the Office Equipment Manufacturers Institute and renamed in July 1961, BEMA represents the entire business equipment industry which consists of approximately 50 manufacturers of computers, office machines, furniture, and related supplies.

Purpose

To conduct programs designed specifically for the needs and problems of member companies. Among these programs are included market research, establishment of standards, and the operation of the Business Equipment Exposition/ Conference.

Publications

News Bulletin
Annual Report

DATA PROCESSING MANAGEMENT ASSOCIATION (DPMA)

505 Busse Highway
Park Ridge, Illinois 60068

History

The National Machine Accountants Association was formed in 1951. In the ten-year period following the formation of the National Machine Accountants Association data processing activities increased at an astounding rate. This rate increase was due primarily to the acceptance of the electronic computer as a vital tool in business and industry. To reflect the changes in the role of data processing, the National Machine Accountants Association was reorganized as the Data Processing Management Association in June, 1962.

Purpose

DPMA is dedicated to improving the data processing profession by creating better understanding of the characteristics and functions of data processing, especially as they relate to needs for education, dissemination of knowledge, solutions of problems, and the proper relationship of data processing to management.

Membership

DPMA has three classes of membership: regular, associate, and honorary. Persons employed in managerial positions in data processing installations are eligible for regular membership. Associate membership is open to those whose occupational activities are related to direct selling of data processing equipment and supplies.

Publications

Journal of Data Management
Data Processing Proceedings From International Conferences (annual)

INTERNATIONAL FEDERATION FOR INFORMATION PROCESSING (IFIP)
32, rue de l'Athene 1206
Geneva, Switzerland

History

The decision to form IFIP was the result of a conference sponsored by the United Nations cultural organization which was held in Paris in 1959. The organization was officially formed on January 1, 1960.

Purpose

To promote international cooperation for the advancement of the science of information processing and the examination of related mathematical and technical problems.

Membership

Restricted to one organization from each country.

Publications

IFIP Bulletin
IFIP News
Proceedings of IFIP (semiannual)
Simulation (monthly)

OPERATIONS RESEARCH SOCIETY OF AMERICA (ORSA)

428 E. Preston St.
Baltimore, Maryland 21202

History

Founded under the leadership of Professor Philip M. Morse at Arden House, Harriman, New York, in 1952.

Purpose

Advancement of operations research through exchange of information, the establishment and maintenance of professional standards of competence for work known as operations research,

improvement of methods and techniques of operations research, and the encouragement and development of students of operations research.

Membership

Persons meeting certain professional requirements may be elected members; others may become associate members.

Publications

Operations Research, The Journal of the Operations Research Society of America
Operations Research Bulletin
International Abstracts in Operations Research
Transportation Science (quarterly)
Directory (annual)

PROJECT ON INFORMATION PROCESSING (PIP)

Montclair State College
Upper Montclair,
New Jersey 07043

History

In 1961, the International Business Machines Corporation contacted the National Science Teachers Association in an attempt to devise a solution to the problem of relating modern data processing techniques to the classrooms. As a result of this contact a committee of representatives from interested groups was formed and in 1961 (PIP) was designated as a project on information processing with headquarters at Montclair State College. PIP is no longer affiliated with the National Science Teachers Association, but is a part of Montclair State College.

Purpose

To serve as a clearing house for information on computer education in the secondary schools.

Publications

Careers in Electronic Data Processing
Computers — Theory and Uses
PIP Newsletter

SOCIETY FOR AUTOMATION IN BUSINESS EDUCATION (SABE)

2-76 Union
Northfield, Vermont 05663

History

Formed in May, 1961.

Purpose

To advance the cause of business education by accelerating an interest in an involvement with automation, computers data processing, programmed learning, and related areas.

Publications

SABE Data Processor

SOCIETY FOR TECHNICAL COMMUNICATION (STC)

1010 Vermont Avenue, N.W.
Washington, D.C. 20005

History

In 1953, two organizations interested in improving the practices of technical communication were founded simultaneously on the East Coast. These two groups merged, and the new organization later merged with a third group that had been founded on the West Coast. This merger became the Society of Technical Writers and Publishers in 1960. The current name was adopted early in 1972. It is the world's largest professional society concerned with technical communication.

Purpose

The society is dedicated to the advancement of the theory and practice of technical communication in all media; aims primarily are for the education, improvement, and advancement of its members.

Membership.

Applicants for membership must have been engaged actively full-time in some phase of technical communication for at least one year. Applicants for affiliate membership must be actively engaged in some phase of technical communica-

tion in allied arts and sciences. Student members must be enrolled full time in an accredited college, junior college, or technical school. Student chapters may be formed when sponsored by professional chapters and approved by the Society's Board of Directors.

Publications

Technical Communication (quarterly)

Intercom Newsletter (quarterly)

Proceedings (annual)

UNIVERSITY OF CALIF.
LOS ANGELES

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CLEARINGHOUSE FOR
JUNIOR COLLEGE
INFORMATION

APPENDIX C

Summary of the Curriculum Pilot Study

Course Title	Semesters taught	Number of sections	Number of students
Advanced Assembly Language Programming	Spring, 1972	1	15
Advanced Business Language Programming	Spring, 1972 Fall, 1972	2	41
Architecture of Computers and Programming	Spring, 1972	1	31
Business Statistics	Fall, 1972	1	8
Computer Operations	Fall, 1972	4	108
Introduction to Assembly Language Programming	Spring, 1972 Fall, 1972	3	73
Introduction to Business Language Programming	Spring, 1972 Summer, 1972 Fall, 1972	4	74
Introduction to Computers and Programming	Fall, 1972	2	132
Special Projects	Summer, 1972 Fall, 1972	2	8
Systems Analysis	Spring, 1972 Fall, 1972	2	32

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